MACHINERY.

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NILES TOOL WORKS FOUNDRY PRACTICE.

PETER J. CONNOR.

THE interest shown by mechanical men in matters pertaining to foundry practice and descriptions of methods of producing castings economically has prompted the writer to attempt to describe some of the practice of the Niles Tool Works, of Hamilton, Ohio. A large number of the castings used in the construction of the machines produced by the Niles Works are of exceptionally heavy weight, and the manner of moulding them requires the exercise of more than ordinary care on the part of all concerned, to prevent serious losses by reason of errors of judgment.

The construction of moulds for castings of such size as it is deemed expedient to make in the manner described below, is accomplished with satisfactory results, although similar castings, have been produced with patterns and also in loam moulds. It is not the writer's intention to discuss the merits of either method, as that is not the purpose of this article, but to describe and illustrate briefly the manner of producing castings such as planer beds, boring mill beds, etc., which can, by reason of their size, be most advantageously moulded in pits in the foundry floor, and in the manner described.

As may be noticed by reference to the accompanying drawings cores are used to form the outside as well as the inside shape of the castings shown. By this method the expensive pattern and loam mould construction is avoided and the shapes of planer beds, etc., lend themselves to it, by reason of their uniform depth.

In the diagrams referred to above, a cross section, Fig. 1, is shown of a mould for a planer bed, in which the letter A denotes the center core and B B are cores which determine the outside shape of the casting. The spaces which are left at the top of the mould and form the flanges of the bed, are closed over by what are termed covering cores, and a plan of the bed with these covering cores in position is also shown in Fig. 2.

The box in which all the main cores are made is generally made for the largest cores, and the others are made in the same box by placing reducing partitions in it.

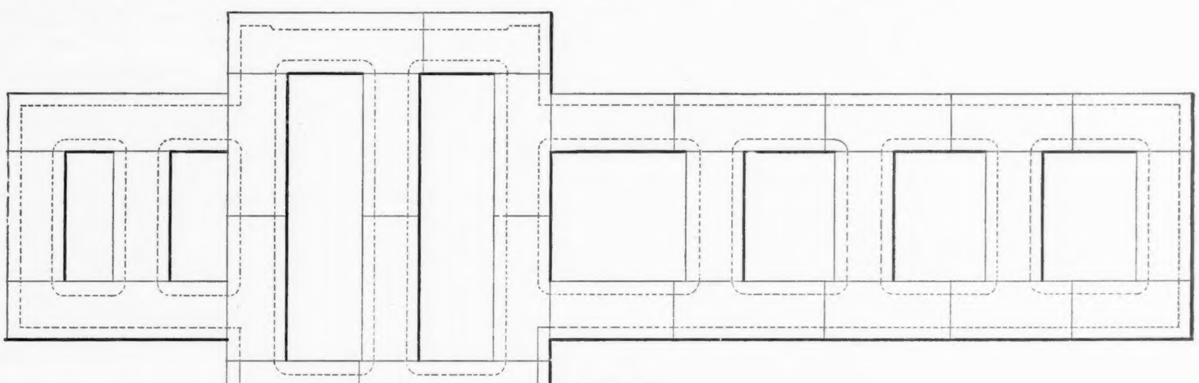


Fig. 2

PLAN OF BOTTOM OF PLANER BED, SHOWING COVERING CORES IN POSITION

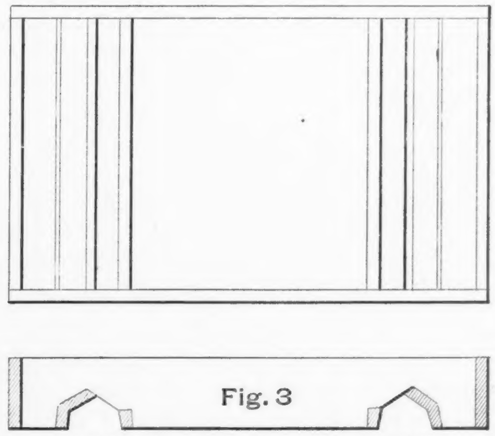
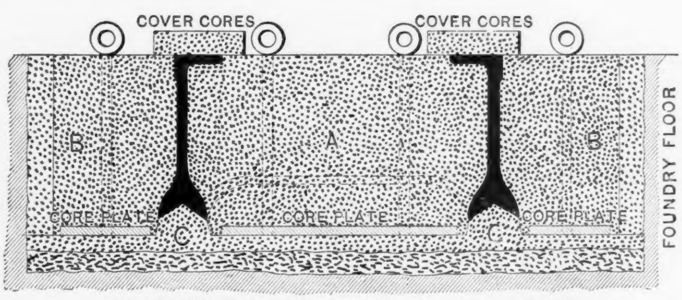


Fig. 3

PLAN AND SECTION OF SWEEP FOR BOTTOM OF MOULD



CROSS-SECTION OF MOULD FOR PLANER BED.

Fig. 1

The methods employed here are the results of many years' experience, and possess features which the writer hopes may prove interesting to the readers of this paper.

The lengths of the center cores A are fixed by the distances between the cross girts in the bed, and the boxes are made long enough so that the joint with the next one, is in the center of the

cross girt. After the pit is dug for the mould, a bed of cinders is laid down, and over this is swept up the shape required to form both the V's and the prints with which to locate the cores. The sweep, Fig. 3, for forming the above parts of the mould is made in about the shape shown in the plan and section. The sweep is left open on one side of each of the V's, in order to allow the moulder to fill in the sand, and when this is done, the open side is leveled off with a strike of the proper shape.

In sweeping up the form required for the bottom of mould, it is necessary to make allowance for the amount of curvature required, so that the casting will not become distorted in cooling. Cast iron core-plates are placed on the bottom of core-boxes before they are filled with sand, and they are provided with lifting rods, either permanent or screwed into the plates. It is preferable to have the rods flush with the top of the box.

All the cores for the interior of the castings are dried in ovens, and those for forming the exterior are dried in position in the mould. After the covering cores are placed in position and sufficient weights are placed on the mould, it is then in readiness to be filled with the molten metal.

The smaller sizes of beds, etc., have patterns made for them, and they are also cast in the floor, but a flask is generally used for a cope in place of covering cores when the mould is made with a pattern.

No attempt has been made to describe a method of venting for this work, but the importance of properly venting all moulds is such that it is sufficient to say it receives due consideration in the foundry, the practice of which the writer has endeavored to describe.

* * *

SYSTEMATIC BOILER DESIGNING.—2.

H. M. Norris.

STEAM.

Steam is divided into four classes—saturated, superheated, dry and wet. Saturated steam, is steam of the temperature due to its pressure, not superheated. Superheated steam, is steam heated to a temperature above that due to its pressure. Dry steam, is steam which contains no moisture—it may be either saturated or superheated. Wet steam, is steam containing intermingled moisture, mist or spray. It has the same temperature as dry saturated steam of the same pressure.

In contact with water, the temperature of steam depends upon the pressure under which it is generated. At the ordinary atmospheric pressure (14.7 pounds per square inch) the temperature is 212 degrees Fahr., but as the pressure is increased, its temperature is increased. According to Regnault's experiments, the relation between temperature and pressure of steam is expressed by the formula

$$t = \frac{2938.16}{6.1993544 - \log p} - 371.85$$

in which p is the total pressure in pounds per square inch, and t the temperature of the steam in degrees Fahr. But since the gauge pressure of steam is about 15 pounds (14.7) less than the total pressure, or pressure measured from a vacuum, it is necessary, in calculating the temperatures of steam under a given gauge pressure, to add 15 to the pressure thus indicated, $150 + 15 = 165$: and $\log 165 = 2.217484$. Hence the temperature of steam at 150 pounds gauge is

$$\frac{2938.16}{6.1993544 - 2.217484} - 371.85 = 366 \text{ degrees Fahr.}$$

The formula for the total heat of steam as deducted from the same experiments is $H = 1091.7 + .305\,(t - 32 \text{ degrees})$, in which t is the temperature of the steam, and H the number of heat units required to generate 1 pound of steam from water at 32 degrees. Substituting our known quantities gives $H = 1091.7 + .305\,(366 - 32) = 1193.5$ B. T. U., the heat required to raise water from 32 degrees into steam at 150 pounds gauge pressure. But with feed-water at a temperature of 120 degrees, it is evident that we shall only require $1193.5 - (120 - 32) = 1105.5$ B. T U. per pound of steam per hour, or a total evaporation of $8000 \times 1105.5 = 8\,844\,000$ pounds per hour.

Where one has access to a table giving the "Properties of Saturated Steam," such as given in Thurston's Manual of Steam Boilers, Kent's Mechanical Engineers' Pocket-Book, or Seaton and Rounthwaite's Pocket-Book of Marine Engineering, the above results may be either read at once, or determined by a moment's figuring. Looking under "Total Heat in Thermal Units from 32 degrees Fahrenheit per pound of the Steam," and opposite the required gauge pressure (150 pounds), we find 1193.5 B. T. U. From this we must deduct the heat required to raise water from 32 degrees (upon which temperature of feed-water the tables are based) to 120 degrees, or 88 degrees, which gives a total of $1193.5 - 88 = 1105.5$ B. T. U., as above.

GRATE SURFACE.

The amount of grate-surface required per horse power depends chiefly upon the character of the coal and the rate of draught. With good coal, low in ash, approximately equal results may be obtained with large grate-surface and light draught and with small grate-surface and strong draught, the total amount of coal burned per hour being the same in both cases. The best results are obtained, however, with small grate surface and high rate of combustion, except with coals high in ash, when a large grate-surface and slow rate of combustion is required, unless means, are provided, such as shaking grates, to get rid of the ash as fast as made.

In designing a boiler when the quality of coal to be used is uncertain, the grate-surface should be made as liberal as possible, say sufficient for a rate of combustion of 10 pounds per square foot of grate for anthracite, and 15 pounds per foot for bituminous coal.

The coals in common use in the United States are: The semi-bituminous coals from Maryland, the anthracites from Pennsylvania, the bituminous coals from Pittsburg and Western Pennsylvania, and the bituminous coals from Ohio and the West.

When burned in ordinary furnaces, these coals will make steam, per pound of coal, in nearly the following proportions:

Semi-bituminous	110	Pittsburg	90
Anthracite	100	Ohio	75

The weights that may be burned in the same grate, with the same chimney, will vary nearly as follows:

Anthracite	100	Pittsburg	120
Semi-bituminous	120	Ohio	200

Relative areas of grate-surface that will be necessary to burn coal enough to furnish the same quantity of steam are nearly as follows:

Anthracite	100	Semi-bituminous	75
Pittsburg	90	Ohio	67

With natural draught, the rate of combustion of a fuel varies very nearly with the square root of the height of the chimney. Under the best conditions it has been found that the weight in pounds of anthracite coal which can be burned on the square foot of grate per hour is, as a maximum,

$$W = 2\sqrt{H} - 1, \text{ nearly,}$$

and under more ordinary conditions,

$$W = 1.5\sqrt{H} - 1.$$

W = weight of coal burned per square foot of grate per hour; H = height of chimney in feet.

The best Welsh and Maryland semi-anthracites, or good bituminous and semi-bituminous coals, should give, as a maximum,

$$W = 2.25\sqrt{H},$$

and the less valuable soft coals,

$$W = 3\sqrt{H}.$$

Thus for Maryland semi-bituminous coal, taking $W = 2\sqrt{H}$ only:

$W = 14$ when $H = 50$
$W = 16$ " $H = 65$
$W = 18$ " $H = 80$
$W = 20$ " $H = 100$

Having found in our preceding paragraphs that the useful heating power per pound of Maryland semi-bituminous coal was equal to 10 708.5 B. T. U., and that the total number of units required by our boiler was equal to 8 844 000 B. T. U., we have now only to settle upon the height of chimney to have all the quantities necessary to figure out grate-surface.

By referring to the table on the next page, taken from a paper read before the American Society of Mechanical Engineers, we see that an 80 foot chimney is the least height we can well use with a 266 horse-power boiler.

Hence, by substituting our known quantities in the formula,

$$A = \frac{T}{C\,(2\sqrt{H})}$$

in which A = area of grate, T the total quantity of heat required

by the boiler per hour, C the useful heating power per pound of coal, and H the height of chimney, we have

$$\frac{8844000}{10708.5 \times 2 \sqrt{80}} = 46 \text{ square feet,}$$

as the area of grate surface required to burn the quantity of fuel necessary to produce the useful heating effect demanded by the boiler.

SIZES OF CHIMNEYS AND HORSE POWER OF BOILERS.

Diameter in inches.	Height of Chimneys, and Commercial Horse Power.											Side of Square, inches.	Eff'tive Area, sq. feet.	Actual Area, sq. feet.
	50 ft.	60 ft.	70 ft.	80 ft.	90 ft.	100 ft.	110 ft.	125 ft.	150 ft.	175 ft.	200 ft.			
18	23	25	27	....	....	....	....	....	....	....	....	16	0.97	1.77
21	35	38	41	....	....	....	....	....	....	....	....	19	1.47	2.41
24	49	54	58	62	....	....	....	....	....	....	....	22	2.08	3.14
27	65	72	78	83	....	....	....	....	....	....	....	24	2.78	3.98
30	84	92	100	107	113	....	....	....	....	....	....	27	3.58	4.91
33	....	115	125	133	141	....	....	....	....	....	....	30	4.48	5.94
36	....	141	152	163	173	183	....	....	....	....	....	32	5.47	7.07
39	....	....	183	196	208	219	....	....	....	....	....	35	6.57	8.30
42	....	....	216	231	245	258	271	....	....	....	....	38	7.76	9.62
48	....	....	....	311	330	348	365	389	....	....	....	43	10.44	12.57
54	....	....	....	....	427	448	472	503	551	....	....	48	13.51	15.90
60	....	....	....	....	536	565	593	632	692	748	....	54	16.98	19.64
66	....	....	....	....	....	694	728	776	849	918	981	59	20.83	23.76
72	....	....	....	....	....	835	876	934	1023	1105	1181	64	25.08	28.27
78	....	....	....	....	....	....	1038	1107	1212	1310	1400	70	29.73	33.18
84	....	....	....	....	....	....	1214	1294	1418	1531	1637	75	34.76	38.48
90	....	....	....	....	....	....	....	1496	1639	1770	1893	80	40.19	44.18
96	....	....	....	....	....	....	....	....	1876	2027	2167	86	46.01	50.27

Where a line of boilers of the same type have all their parts designed in accordance with a certain ratio, and their average performance under like conditions has been determined by actual trial, the grate area required for any evaporation may be readily found, by the formula

$$G = \frac{E\,F}{C\,W}$$

in which G = grate-area, E = required evaporation, F = factor of equivalent evaporation, C = pounds of coal per square foot of grate per hour, and W = pounds of water evaporated, from and at 212 degrees per hour, per pound of coal. Thus, supposing the boilers to burn an average of 15 pounds of good anthracite coal per square foot of grate per hour, and to give an average evaporation of 10 pounds of water from and at 212 degrees per hour, per pound of coal, the grate area required to evaporate 8 000 pounds at 150 pounds pressure, from feed-water of 120 degrees temperature, with the same coal, would be equal to

$$\frac{8000 \times 1.1445}{15 \times 10} = 61 \text{ square feet.}$$

Anthracite coal has not, however, as great a steam making power per pound as the semi-bituminous coals; the relative areas of grate-surface necessary to burn enough coal of each kind to furnish the same quantity of steam having been given as 100 : 75, so, for the latter coal, we shall only require a grate-surface of $61 \times .75 = 46$ square feet approximately, as determined above.

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MECHANISM FOR MECHANICS.

Prof. Chas. H. Benjamin.

Mechanism is the science which deals with the laws of motion in machines; it teaches us to understand old machines and to design new ones.

MACHINES.

The ordinary definition of a machine is as follows:—

A machine is a combination of fixed and moving parts put between the power and the work to adapt one to the other. The power may be in the pressure of a current of steam, water or electricity, or it may be simply taken by belts or gears from a line shaft.

The work may be the turning of a shaft, the pushing of a pump, the cutting, grinding or stamping of some material or any other of an almost infinite variety of processes. For instance, a steam engine is a machine put between steam and a fly-wheel to enable the former to drive the latter. The object of a machine is then to change motion, it may be to change its amount, its direction, its kind or sometimes all three.

MOTION.

A machine consists of the frame or stationary part, and the moving parts.

The motion of these latter is always with reference to the frame; for instance, it matters not whether an engine is to be locomotive or stationary, we always consider the frame as stationary when designing the moving parts. All motion is relative; a point on the rim of a driving wheel describes a circle with reference to the frame of the locomotive, but a cycloid with reference to the track. As mentioned above, motion may vary in direction, kind or amount.

A pair of gears or a crossed belt, may change the direction of motion and, if the gears or pulleys are of different sizes, may also change the speed or amount of motion. A connecting rod on an engine or pump changes the kind of motion from straight to circular, or the reverse.

VELOCITY.

Velocity or speed, means the amount of motion in a unit of time, as one minute or one second, and is usually expressed as so many feet per minute. For instance, if a certain piece moves 84 feet in 12 minutes, it is said to have a velocity of 7 feet per minute.

In order to determine velocity we must then divide the distance moved in feet by the time in minutes. As this is a convenient way of measuring the motion of pieces moving in a straight line, it is sometimes called *linear velocity.*

ANGULAR VELOCITY.

When a piece rotates or turns on an axis, it is more convenient to measure its motion either by the number of turns per minute, or by the angle turned through in the same time.

The latter expression is called the *angular velocity*, and may be measured in degrees, or—as is more common—by the velocity of a point one foot from the center. In one revolution or 360 degrees, a point one foot from the centre will move 2π or 6.283 feet, in two revolutions twice this—and so on.

The angular velocity of a turning piece is then equal to the number of revolutions per minute multiplied by 6.283, or as it is expressed in algebraic symbols:

$$a = 2\pi N \quad \text{- - - - - - - - - - - - - -} \quad (1)$$

The velocity of any other point in the piece is, of course, proportional to its distance from the center; that is, a point two feet from the center will move twice as fast as a point one foot from the center. In other words, the velocity of any point in a turning piece is equal to the angular velocity multiplied by the radius, or in symbols:

$$v = ar = 2\pi Nr \quad \text{- - - - - - - - - - - - -} \quad (2)$$

Example 1.—A pulley 5 feet in diameter makes 150 revolutions per minute. Determine the angular velocity of the pulley and the linear velocity of its rim.

Solution: The angular velocity $= 2\pi N = 6.283 \times 150 = 942.5$ ft. per minute. The distance of rim from center to center is $2\frac{1}{2}$ ft. therefore its linear velocity $= ar = 942.5 \times 2.5 = 2356$ *f.p.m.*

The object of gearing and belting is usually to change the angular velocity; the rims of two pulleys, connected by a belt that does not slip, move at the same linear velocity, but the angular velocities will be *inversely* as the radii.

VARIABLE VELOCITY.

It frequently happens that a moving piece has a speed which is continually changing; for example, the cross-head of a steam engine moves very slowly when near the ends of its stroke, and faster as it nears the middle of the stroke. In such a case we must distinguish between the average or mean velocity and the actual velocity at any instant. The average velocity is the actual distance moved in a unit of time.

Suppose that the engine, referred to above, has a stroke of three feet and makes 100 revolutions per minute, then the average velocity or mean speed of the crosshead and piston is: $2 \times 100 \times 3 = 600$ ft. per minute, or, as it is usually called—the piston speed. The actual velocity at any instant is measured by the distance that the piece would move in a unit of time if it continued at the same speed and in the same direction as at the instant in question.

For instance, in the case of the engine when the crank is vertical, the crosshead is moving at the same speed as the crank pin. Using the same dimensions as before, it is seen that the crank pin moves $3 \times 3.1416 = 9.4248$ feet, or the circumference of the crank circle in each revolution, or $9.4248 \times 100 = 942.5$ feet per minute. The crosshead, when near the middle of its stroke, has then an actual velocity of 942.5 feet per minute.

When we say that the speed of a railroad train is 30 miles an hour, we refer to the mean speed. The velocity at any given instant may be very different from this. Hereafter, when we speak of the velocity of a piece or point, we shall mean the actual speed at that instant and not the mean speed.

REPRESENTATION OF VELOCITY.

Velocity is most easily represented on paper by a straight line having a direction the same as the motion, and a length which measures the velocity to some convenient scale. The velocity of a point in a piece which is turning, is represented by a straight line perpendicular to a radius drawn from the center to the point, the direction of the line showing in what direction the point is moving at that instant. (See Fig. 1).

Let P and Q be two points in a disc, which turns, as shown by the arrow, and let P be twice as far from the center as Q, then will the lines Pp and Qq, perpendicular to CP and CQ respectively, represent the velocities of P and Q at this instant, and Pp will be twice as long as Qq. If CQ were one foot in length, then Qq would represent the angular velocity of the disc.

COMPOUND MOTIONS.

The motion of a body is sometimes due to two or more separate forces, and is different from the motion that would be produced by either force acting alone. A familiar example of this is seen in the motion of a boat rowed across a stream having a strong current. (See Fig. 2).

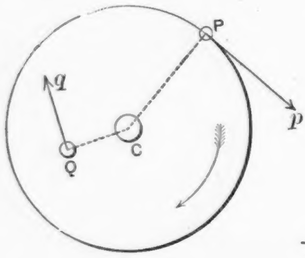

Fig. 1

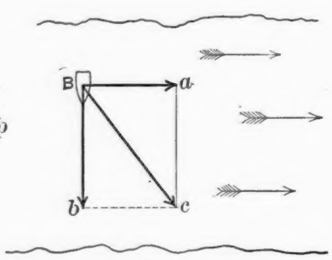

Fig. 2

Let B represent the boat being rowed across a stream, the direction of the current being shown by the arrows. Suppose that the velocity of the current is 3 feet per second, and that the oarsman can row 4 feet per second. In 1 second the boat, unaided, would drift 3 feet down stream to a. But in the same time the oarsman could row the boat, in still water, 4 feet to b. When both forces are acting, the boat will move in the direction Bc and in 1 second will be at c, 5 feet from the starting point, since $3^2 + 4^2 = 5^2$.

The real velocity of the boat is then 5 feet per second represented by Bc, and this is said to be the resultant of the velocities Ba and Bb, due to the separate forces, while Ba and Bb are called component velocities.

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ANNEALING MUSHET STEEL.

Having received several inquiries regarding the annealing of Mushet steel, which was mentioned in the last issue in connection with the milling cutter sent us by Mr. F. J. Gay, of the L. S. Starrett Co., Athol, Mass., we obtained from him a brief description of the way in which it is done, which is sure to be of interest to the readers of this paper. We regret that lack of time prevented us from reproducing an engraving of the cutter, as the amount of work on it indicates that it must necessarily have been thoroughly annealed.

The steel is annealed in exactly the same manner as the best tool steel; in this case in a furnace which will take a piece 12 inches in diameter by 6 feet long. All steel which they anneal is packed in tubes of such diameter as will include a proper amount of charcoal, the tubes then being sealed or luted with fire-clay. All steel remains in their annealing furnace twenty-four hours. The amount of heat is limited by the rate of absorption into the steel until the proper heat is attained, when the steel is allowed to cool gradually, the whole operation requiring about twenty-four hours, as previously stated.

The expense of such a furnace, as well as of the necessary skill, is hardly warranted in the average shop, and it is advisable to send to a shop having a specially equipped plant.

Mr. Gay thinks it possible that self-hardening steel may be annealed in less actual time than that named, but they anneal such a small amount of this steel as compared with their regular tool steel, that they are worked in together, and no experiments in this line have been made.

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BRASS FOUNDRIES.—2.

TUBS, SEPARATORS, RAPPING.

Improvements in the other departments of the brass foundry are about as scarce as with the furnaces, although some of the more modern ones show advances over the all too common method of paying little or no attention to convenience, which usually means economy.

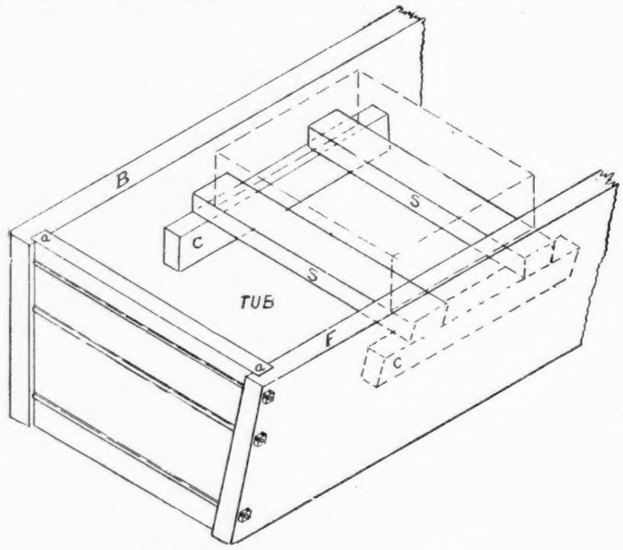

FIG. 5.—REGULATION MOULDING TUB.

The regulation moulding-tub is a huge, trough-like arrangement, an outline of which is shown in Fig. 5. This is made of about 2-inch planking, the ends let into the sides as shown at *a a* and held by iron rods with nuts at end. Substantial cleats are fastened to back B, and front F, as shown by *c c*. Strips S S are laid across the cleats in the right position for the flasks being used, the dotted lines show position of flask. The tub is more or less filled with sand which is "tempered" by the moulder according to his judgement and disposition. The ramming process, after the sand has been sifted in the flask, is rather amusing to an outsider and he may well wonder that more castings are not spoiled, as the ramming is apparently done in a hap-hazard way with little possibility of uniformity. First a base drum tune is played on the sand with brass rammers, then more sand thrown on and, with a dexterous swing, the moulder is seen jumping

FIG. 6.—VIEW IN FOUNDRY—TUBES, FLASKS AND MOULDS.

on the flask and doing a little song and dance all to himself—sometimes without the song, however. A little venting with a long thin wire and the flask is ready for its cores and then to be clamped and receive the metal.

Fig. 6 is from a photograph of the same foundry as the square furnaces in the January paper; the top light from the large skylight being very prominent. The moulder at the left is working at the tub, which shows its height and general dimensions, two other tubs are shown at the right, with flasks piled against them, while in the foreground several moulds are on the "spill troughs" waiting for their cores and to be clamped ready for pouring.

Figure 7 shows about the only convenient appliance found in the foundry referred to, this being a large funnel for feeding brass turnings and other small scrap into the crucibles to make the required mixture. This is about the size of the pot at the bottom and probably three feet in height.

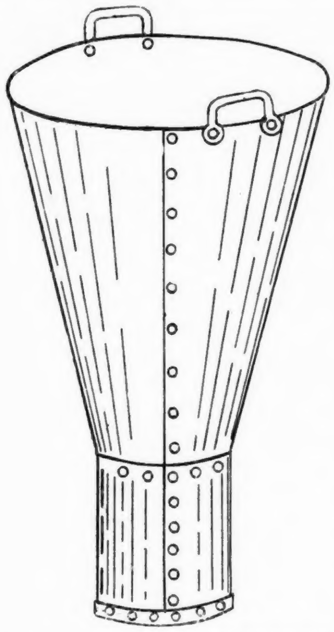

FIG. 7.—FUNNEL FOR FEEDING BRASS TURNINGS.

In this connection it may be interesting to note the magnetic separator which is used to separate the iron or steel particles from the brass turnings, as the small spots of steel in a brass casting that is to be turned or threaded, is apt to spoil a tool and cause profanity, especially if the workman is on piece work. The brass turnings are slowly sifted, automatically, of course, over a revolving brass covered cylinder, which contains a large number of horse shoe magnets set in cement or plaster of paris, with their ends pointing outward. These attract the particles of iron and hold them until they are removed by a scraper on the back of the cylinder.

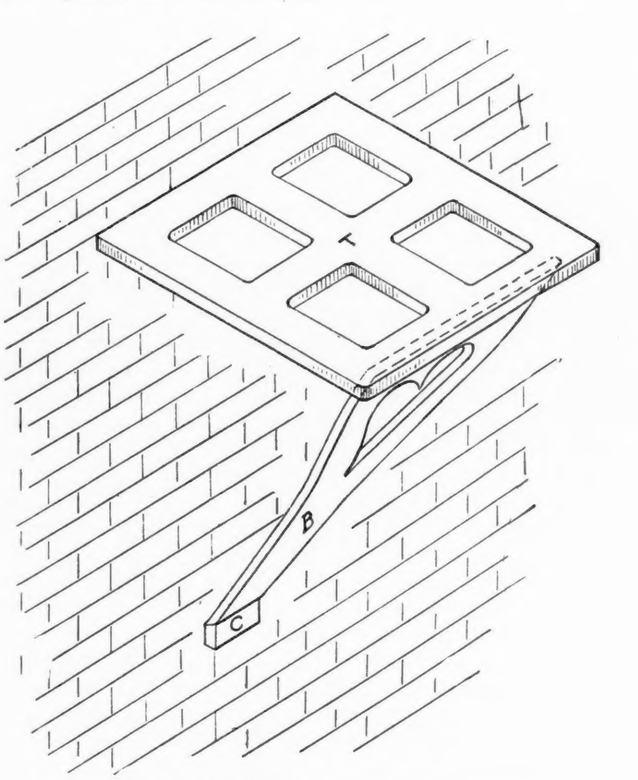

FIG. 8.—NEW FLASK TABLE OR BENCH.

It is sometimes asked where these iron or steel particles come from. The majority of the steel removed by the separator is in very fine particles and is undoubtedly worn from the tools used, the occasional breaking of a tool point also adding to the collection.

In the foundry of H. Belfield & Co., the moulders' tubs have been done away with, and instead the flasks are held on a cast iron table or shelf, the sketch in figure 8 giving an idea of it. The sand is kept in bins or on the floor beside the moulder and the whole arrangement is much neater and more compact than the old arrangement of tubs. Another advantage is that it does away with the "say Jim, gimme a rap," which is usually heard in the foundry; then Jim takes a couple of rammers and beats the liveliest kind of a tattoo on the inside edge of the tub, the object being to give enough vibration to the mould so that the sand will leave the pattern readily and allow it to be drawn out freely. Mr. Belfield told the writer that, although his moulders were fearful they could not get along without the customary rapping, they had no trouble if the pattern had an ordinary amount of draft. The saving in time (for one moulder generally "raps" for his neighbor, the ordinary foundry laborer not being usually considered expert enough to give the required rythmic rapping) amounts to considerable in the course of a year, to say nothing of the foundry being much more quiet than before.

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THE EVOLUTION OF PROCESSES.

A MONOLOGUE ON EVOLUTION—ALUMINUM AND EXTRUSION—THE TWENTY YEAR PERIOD—HYDRAULIC EVOLUTION—MR. DICKIE ON PACKING.

A history of the popular or first acceptance of new processes and implements in the mechanic arts, if compiled, would go far to show how little of known truths and rational analysis enters into the case. It would also show that all estimates of new processes had been wrong in not recognizing a period of "evolution" through which all processes must pass.

It is not long since extravagant opinions existed respecting aluminum as a constructive material, but since then half a score of other things have been gone over in the same manner, winding up just now with the "extrusion" method of making metal bars, and this as the last "wonderful process" admits of special remark.

The progress made in giving definite shape to metal products by pressure, when the material is heated to softness, has always lagged far behind what inference points out. Many years ago—twenty or more—announcement was made of the successful rolling of lag screws, and every one expected that we had seen the last of cutting away two-thirds of the metal from a stem to form a thread, also that we would have lag screws with a shank or stem of a diameter equal to the core, a thing very desirable in some cases, but the scheme never reached fruition.

Die and press forgings have certainly attained an important advance in metallurgic processes, but so long as polygonal bars large enough to form the head of a screw are cut down to half or one-third of the section to form screw stems, there is certainly something to do in plastic or hot treatment. The impediment of high temperature has deterred people from such experiments, not only because of the effect upon implements and dies, but because finishing done at high temperature or any temperature above normal heat, must be inexact and lack true dimensions.

This latest invention in plastic treatment, the "extrusion" process, has long been applied to the manufacture of lead pipes, plumbago cores for pencils, and in other cases where the temperature does not interfere with dies through which the material is forced. In metals, the process has been confined to alloys, especially delta metal that has high ductility, but with some promise of extending to iron and steel.

The process is simply confining the hot metal in a strong cylinder or barrel, from which it is expelled by a powerful plunger, the metal extruding through a die having a form corresponding to the required section, which may be of any character.

The operations in England and in Germany, described in a recent paper read before the Iron and Steel Institute at London, relate to producing symmetrical bars off of delta metal; the pressure applied being about 500 tons to produce rods one inch in diameter when the alloy was at a temperature of 1 000 degrees.

In respect to working iron and steel in this manner it may be a long way off. In the Whitworth process of compressing molten steel there must be involved the main elements of an extrusion process, that is, a retort or containing vessel and displacing plunger, exposed to high temperature and high pressure.

It is significant and not assuring that the Whitworth Co. have not attempted "extrusion," although having the main element at

command; still the subject has some interest for inventors who have at control the expensive agencies required. It must be remembered, however, that in comparing with die shaping, or, as we may call it, lateral action, the extrusion process must be confined to uniform parallel sections or to rods and bars.

The destruction of dies by the rubbing action of the flow will no doubt impose a limitation. In direct or lateral processes, such as pressing and rolling when there is but little sliding action, the wear of dies is a considerable factor in first manufacturing cost, and this expense will be much increased by pressure and movement on the shaping surfaces or dies.

The treatment of metals to the unskilled, presents an anomala. The common conception is, that they should be smashed and pressed into all kinds of shapes, at once. Looking at a planing or turning tool at work, the first thought is, why not set half a dozen tools side by side or use a broad one, and "cut it off and be done." A person unacquainted with metal turning looks on with disgust and wonders how an owner can stand such fooling away of time.

Behind all these processes are limiting conditions, inscrutable even to science in some cases, but immutable all the same and learned by experience to such an extent as to become an exercise of habit instead of calculation. A workman will put in a lathe, pieces of various diameters and of different kinds of material, adjust the cutting speed at once and not think of it again. He is sensible of the limit but cannot explain it.

The Mannesmann process that some time ago created much noise in the field of hot treatment, like extrusion, must pass through an "evolution," a long period of experiment, even in these times, and the sudden discovery, or first discovery, is merely opening the way to a long vista of tentative effort that lies in the future. Mannesmann tubes have found a place in the commercial field, not wide, but permanent, perhaps, and much to be wondered at too, when we consider the enormous strains to be endured by the implements required in rolling them.

Electrolytic deposition of copper on mandrils to form tubes is another of the exciting discoveries of recent date; indeed they follow in tolerably regular sequence and are not to be disparaged or disputed, but the long train of evolution is inevitable, and estimates should always include this no matter what the first promise may be.

High pressure steam has been on the road more than twenty years, water tube boilers thirty years; bicycles forty to fifty years. The American automatic steam engine valve gear had a good start at Salem, Ohio, twenty years ago, and reached the "type stage" within five years past. To load a shot gun at the breech instead of the muzzle required two decades, in fact the twenty year period seems to be a kind of uniform standard for development, or is an average time in which permanent types are reached in the constructive arts; shortening in our time to be sure, when compared to fifty years ago and before that, but equally inevitable.

It would be easy to name scores of examples to illustrate this cause of evolution in machine processes and manufactures. It would also be possible to show how success or failure can with a good deal of certainty be predicted by inductive conclusions, based upon known rules and precedents, at the hands of skilled and impartial people. It is in fact a common trait of mind in skilled people to frame a conclusion repecting any new thing that comes to notice.

There is an intuitive first impression which for some unaccountable reason is often more reliable than later and more considered views. Mr. W. B. Bement, Sr., founder of the Industrial Works, at Philadelphia, had a good rule, that "First impressions were generally correct," and there is much to sustain this claim on the part of those competent to judge of new things.

The evolution of hydraulic apparatus that was in nearly all essential features discovered and applied by Bramah at the beginning of the century, is a good example of the time required to develop new processes after the original conception is complete and the conditions computable. The premises in this case may be set down as follows:

A mobile fluid, flowing with a minimum of friction, as inelastic and incompressible as the hardest metals, present everywhere and without price, free from danger and available at a normal temperature.

Now an inference from this will be, if suitable containing vessels and pipes could be provided, this medium should have come at once into use to transmit, multiply and diminish power through short distances. Such was not the case. Down through nearly a century of evolution, we find hydraulic apparatus moving a step at a time, slowly, sometimes turning backward, as in the case of cup leathers, which, like a barnacle, attached itself to hydraulic devices as an only means of maintaining joints under high pressure.

An illustration of this fallacy will be in place here and perhaps of more use than all the rest that has been said. When the Palace Hotel, at San Francisco, was built about twenty years ago, there were provided five hydraulic elevators or a very advanced type, designed by Mr. G. W. Dickie, now manager of the Union Iron Works in that city.

These elevators were on the Armstrong system, with multiple rams, that were cut out or combined as the loads required; the water was controlled by balanced water-moved valves. The rams, about twenty in number for the five elevators, were all packed with cup leathers, so also was the accumulator ram, 22 inches in diameter.

The cup leathers gave away continually, so a force of men had to go each night to renew the packing, and the expense was so great that the work worth $50,000 could not be accepted by the hotel owners. One day, in desperation, when the accumulator ram packing blew out, some "rounds" of common hemp packing was inserted to last until the elevators could be stopped at midnight, but as there appeared no leak and there were plenty of other rams to pack, this one was risked for another day, and so on for a week and then for a month.

The cup leathers were pulled out all over the place and common hemp packing substituted. The difficulty ended, the work was paid for and remained for seventeen years without change; the cost of maintenance, Mr. Dickie said, was as 400 to 1 in favor of the hemp, and he thought hydraulic practice would have been much more advanced if the inventor of cup leathers had never been born. He is consistent, too, because he does not permit this kind of packing in the great works over which he presides.

* * *

LIGHTING THE SHOP.

HERBERT PRATT.

I am often asked by machine-shop owners and others similarly situated, "Will it pay me to put in a plant for my own electric lights; and if so, what kind of an arrangement would you advise?" I will endeavor to answer these questions in a general way, in hopes that it may help some one to decide rightly.

In a place where light is only needed a few hours a day and your steam plant is quite fully loaded, you can without doubt get your lights from the central station cheaper than you can install the necessary plant. If your steam plant is not loaded, or if you are to burn your lights several hours per day, then it will pay you to make the necessary installation.

You can easily find the power required by figuring on ten incandescent or one arc lamp to the HP. You will probably be told that you can run fourteen incandescent lights to the HP., and that an arc lamp only takes three-quarters HP., but as you do not wish to get everything in and then find you are short of power, the first figures are the safest to work by unless it be a very large plant.

In case you find you have the power and would like to light your place, the kind of light, whether arc or incandescent, will come up and in most places it will be found advantageous to use both kinds. You may have been told and are possibly under the impression that it is necessary to have a constant potential machine for incandescent and a constant current machine for arc lights. While this was true a few years ago it is not now, and several companies will be glad to furnish you an arc lamp to be run on your incandescent circuit, and lamps too, that it will only be necessary to trim every 150 hours. This simplifies matters greatly, and you will naturally decide to put in a constant potential dynamo. You will probably also decide to put in a compound dynamo rather than a simple shunt wound machine, as you wish the voltage constant with varying load without having a man going to the rheostat all the time. The question of voltage is practically decided for you, as 110 volts is the standard for this kind of work.

In selecting the position for your dynamo, get it in the engine room if possible; if not, place it as near there as convenient, for your engineer is naturally the one who will have the care of it.

If possible, belt direct from line shaft with a good friction clutch on shaft, but if you cannot spare the space for belt, the "L. P. D." driving system will be found very satisfactory and quite compact. There is another device which, while more compact, will be apt to cause you more trouble, as everything has to be so exact for its successful operation.

If it is necessary for you to install a steam plant for your lights then by all means put in a direct connected engine and dynamo. Then you can run your lights without running all your shafting, and this will be found very handy many times.

In case your engine and shafting are loaded and you need more power in different parts of your shop, it will be a big expense to put in a new engine and make the necessary changes in the shafting; while if you put in a direct connected machine of large enough capacity to run motors, you can place the motors in the most convenient place to give you the extra power needed and run wires from the generator to them.

If you have much power to transmit you will find a great saving in copper if you use 220 volts instead of 110. A great objection to a 220 volt motor circuit used to be that if you wished to use incandescent lights you had to have a separate machine or use two lamps in series. This objection has at last been overcome, as you can now use a 220 volt incandescent lamp that will burn satisfactorily.

Your switch-board should be placed handy to your dynamo, so that the man in charge can look at both at the same time. If your plant is small and has only one circuit, you will want one fused switch for full capacity of dynamo, one volt meter, one ampere meter and the rheostat for the dynamo, on your board.

If you have more than one circuit, you want in addition to the above, a fused switch for each circuit, and have each switch marked so as to readily distinguish which circuit it controls. Slate is the best material for mounting these switches and instruments on, although a skeleton frame of hard wood can be used; in either case it should be set out from the wall, so that a man can get in between the wall and board to work, or to inspect the connections.

The best way to arrange your circuits, in most cases, will be to run a separate set of wires from the switch-board to a center of distribution on each floor. At this point bring all your circuits in the room, and place them where the foreman can turn on the lights in his room as he sees fit, having a fuse and switch to each 10 or 12 lamps.

If you have motor and lights both, it will be found best to run a separate circuit to each from the switch-board, the lights arranged as above, and the motor circuit running direct to the motor where you have your switch and starting box.

When installing your plant, whether you do the work yourself or it is done by a construction company, you will do well to get a set of insurance rules, and see that the work is done in accordance with them, or better, get some one who knows the business to look after the work.

In taking care of your machines, either dynamo or motor, there is more trouble caused by improper setting of brushes than any other one thing. If you use copper or gauze brushes they must be fitted and set exactly to line; then they must be looked after often, as they will wear or flatten out and will soon be at work wearing the commutator, which is the vital part of the machines.

If carbon brushes are used, one should exercise great care in fitting them, as they will not fit commutator well unless pains are taken, and a good contact is essential to their proper working. After they are once fitted they do not require the attention that copper brushes do, for if the holder is designed correctly, the brush will keep in line as it wears. Anyone using a copper-wire or copper-strip brush on their constant potential dynamos, will find that the gauze brush will give them better satisfaction in nearly every case.

There are few machines, however, which are designed for copper brushes that will work better, or as well, with carbon brushes, for, in designing a machine for carbon brushes the commutator is made larger, as it is necessary to get more bearing or contact surface for carbon than copper, on account of its higher resistance.

In using copper brushes, it will be found to your advantage to use vaseline sparingly on the commutator, or in place of vaseline, if you haven't any handy, the next best thing to use is engine oil. Whichever is used should be put on a piece of cloth and the commutator wiped with this while it is running; don't use too much, for if you use enough to gum up the machine, it will be worse than using nothing. Use just enough to prevent the brushes from cutting the commutator.

With carbon brushes it will be seldom necessary to use anything on the commutator except to wipe it off with coal oil or kerosene occasionally. If the brushes grate and heat the commutator, a piece of paraffine held in a rag against the commutator for a second will help greatly; but the best way of all is to take the brushes off and soak them in melted paraffine; they will thus absorb quite a little, which will then lubricate the commutator as it is needed. The brushes should be cleaned when they get filled with dirt, by taking them off and soaking them in benzine. If your commutator is true it is an easy matter to keep it so by the proper attention to it and the brushes; if they are rough or out of true, you should have them turned true immediately, as no man can make them run satisfactorily in this condition. They will be constantly getting worse and will soon have to be replaced. Get the commutator smooth and keep it so, and your machine will be ready any time you need it.

* * *

STRENGTH OF GEAR TEETH.

W. H. Booth.

I have been advocating short gear teeth for fully twenty years, as I became convinced at that time that the common proportion of length = ¾ pitch was excessive. I was partly lead to this conclusion from actual experience in the behaviour of a good deal of wheel gearing and partly by induction. I discovered—hidden away in the pattern loft—some large patterns of wheels of which the teeth were as long as the pitch, and the ordinary teeth seemed so short beside them that there was no apparent reason why an equally drastic further shortening should not be equally effective. Hence my present practice of length = ½ pitch and I do not see why this should be final. For large gears of four or five inches pitch, a length of only ⅜ inch has been recommended by the engineer of one of the engine insurance companies—but he conceals the true proportions by adding rounds and hollows, so that in appearance his teeth look as though made semicircular above the pitch line, and joined below pitch line also by semicircles. This, perhaps, suits the eye of the non-technical man, but to an engineer the system is bad, in that the rounds and hollows are so much superfluous weight which has absolutely no use. What I aim at in a tooth is, such a length as will reduce the chance of breakage to a minimum, and at half the pitch the appearance of a tooth is one of strength. Then, again, as my experience was with large and heavy cast gears and not with cut teeth, it seemed objectionable to me that teeth should form much contact before the line of centres owing to the harsh nature of the contact which then occurs, especially where the approximate accuracy of casting alone is in question. Though I have not yet carried it out, I have felt for some time that if the teeth of the driver were to be continued only a very short distance within the pitch line, the tooth being almost entirely points or projections beyond the pitch circle, and the teeth of the *driven* wheel were to be made almost wholly flanks, projecting hardly beyond the pitch circle but lying almost wholly within it, then there would be no serious contact until the teeth had passed the line of centres, and the friction would be much reduced. The old rule was to assume that the stress might come on a tooth corner, and as Mr. Webber well remarks, "the making of a wheel more than two pitches wide would be useless." With short teeth the blow on the corner will be far less severe, but I maintain that if the corner is liable to such blows as to demand consideration in calculating strength, then the corner ought not to be there; it ought to be thinned away to the extent of the probable error in the casting. With modern mill gearing, there is no difficulty in securing good and even meshing of any pair of wheels, and in a very short time the teeth will bear their full length, and my own practice for slow-running gears has been to simply increase the breadth of face according to the power to be transmitted. Thus, I would use one wheel, and order it from 2½ to 5 inches in breadth, with a pitch of 1½ inches. The diameters for many different powers would be alike. All these wheels, with such different ratios of pitch and breadth, worked equally satisfactorily. As a rule too much play is allowed between wheels. This has arisen from the use of long teeth, and may be very much reduced if teeth are made shorter. With absolute accuracy there would be no need for play and there could be no backlash, but the inaccuracies of long teeth call for so much play that if there is any backlash, the rattle will be very

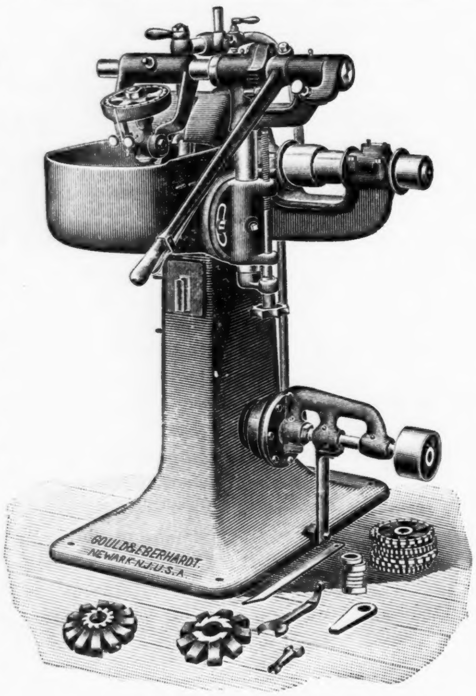
marked. In every way, therefore, the short tooth has great advantages over the old-fashioned long tooth, but it is very difficult to persuade people to use the short ones. Most people are so tied down by precedent and so adverse to using their brains to think the matter out, that they continue to use the dangerously weak form of tooth rather than face a change.

* * *

A NEW CUTTER GRINDER.

The accompanying illustration shows a water grinder for grinding gear or milling cutters, which has been designed and patented in the United States, Great Britain and Europe, by Messrs. Gould & Eberhardt, of Newark, N. J., and is something new in grinding machinery. It is built with the view of grinding either gear or milling cutters radially and equi-distant, and at the same time overcomes the heating of cutters, by a novel arrangement of water spouts, which thoroughly deluge the cutter and keep it perfectly cool during the grinding operation.

The firm state that it was the pressing need and demand for just this kind of a machine that forced them to design this one. They could not purchase a machine to accomplish their purpose, as there was none on the market. A machine was needed to grind the ordinary rotary cutters properly and also to grind the radial gang cutters, which have become so popular.



NEW CUTTER GRINDER.

Their own shop showed the great necessity for such a machine. Expensive cutters were being ruined by improper grinding, and judging from the correspondence of those using cutters, they concluded that many other manufacturers were in the same predicament.

Considerable difficulty was experienced in designing this machine, one of the greatest obstacles being to keep the cutters cool and accurate. They believe, however, that they have now solved the problem with this machine, as the results seem to be so perfect that by its use an inexperienced workman can grind cutters without the slightest danger of injuring them. It is very essential to keep the cutters sharp, as with sharp cutters an automatic gear cutter can produce from 30 to 50 per cent. more work than with dull ones.

The grinding of these cutters has always been a matter of considerable experimenting, as with the old dry grinder, cutters were too frequently ruined. By the old method a workman was always apt to grind some teeth either too much or too little, and draw the temper of the cutting edges; consequently the higher teeth would do all the work and soon heat up, lose their temper and become dull.

The fact that cutters become dull at the point first, is apt to make a workman using an ordinary grinder, alter the shape of the cutter tooth by taking too much off the end, in his endeavor to grind that portion of the cutter sufficiently. A tooth formed by such a cutter will not be the correct shape, and poorly running gears will result.

With ordinary grinders, in grinding gangs of cutters, it was necessary to either separate the cutters and grind each one separately or to grind them slowly and cautiously in gangs. The former method was very difficult, and required much time and judgment to grind the teeth equally. To cut the entire gang at one setting also required an amount of acquired skill, and to guard against heating the cutters and drawing the temper it was necessary to work very slowly. These difficulties seem to have been overcome by this machine.

An abundant supply of water is forced on the cutter, being thrown from both top and bottom simultaneously, thoroughly deluging the cutter and keeping it perfectly cool. This does away with all possibility of drawing the temper of the cutting edge.

The method of feeding the cutter while grinding is also a very essential part of this machine. The cutter to be ground is mounted on a spindle with an index dial, which accurately divides the cutting teeth. The cutter is fed forward by a lever, by which the cutter may be instantly swung up in a vertical position to admit inspection. A stop regulates required depth of tooth, thus insuring an even equi-distant cut around the entire cutter.

The feed is also very short, as the emery wheels grind in towards center of wheel and not vertically across the face. This saves considerable time in grinding gangs of cutters. The almost direct connection between the lever and the cutter gives the operator that sensitive touch which is necessary in grinding cutters by hand.

Gangs of cutters can be ground at one setting in a very short time with this machine. Each cutting tooth will be ground properly and the entire gang radially and equi-distant. It is impossible to heat the cutters, as the stream of water thoroughly deluges the entire gang just as it does the single cutter. Gangs of ordinary size can be ground almost as quickly as the sharpening of a single cutter.

A skimming pan receives the water directly after it leaves the wheel and frees it from all floating substances and sediment which would otherwise destroy wearing surfaces.

The machine can also be made to grind the entire cutter automatically without attention, after being set; at, of course, an additional charge.

* * *

Messrs. Wiebusch & Hilger, Ltd., and the J. Stevens Arms & Tool Co., whom the former have for years represented, have dissolved this connection by mutual consent, and the J. Stevens Arms & Tool Co. will hereafter have their own office in New York at 79 Chambers street, in charge of Mr. Chas. Folsom. Their English office is 96 Tabernacle street, Finsbury, London, E. C.

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TWO CYLINDER COMPOUND LOCOMOTIVES.

The January number of the *Journal of the Franklin Institute* contains an extremely interesting paper by our well-known contributor, John H. Cooper, on the performance of Two-Cylinder Compound Locomotives. This has been compiled by Mr. Cooper and his associates, based on the reports of various railroads from the actual performance sheets of these engines, which show the value of compounding locomotives, when the cost of maintenance does not more than balance the fuel saved, as has been the case in many instances with other types of compound locomotives.

The lack of signatures to the reports will probably be quoted as evidences of their unreliability, but none who know of the vast power exercised in the making and unmaking of railroad officials in various parts of the country, will wonder at the reticence of those who do not propose to present their official heads to the manipulation of the railroad guillotine.

The data shown in this article demonstrates beyond a doubt that the Two-Cylinder Compound shows economy of fuel equal to that of any other type, and when properly designed and constructed, the cost of maintenance is no greater than that of a single expansion engine, doing the same work.

* * *

It is an unhealthy state of affairs when it is more profitable for a steel mill, a sugar refinery or any other well equipped plant, to to lie idle than to run and give employment to several thousand persons, yet this is the case with the Lackawanna Iron & Steel Co. and the Franklin Sugar Refinery, at present. With splendid plants in their respective lines, they are paid more by the Steel and Sugar Trusts to lie idle than they could make running, in order to keep up prices by limiting the supply. It may be asked whether it would not be as profitable for the trusts to sell at a lower rate, as to pay so much of its income to mills for not running; but lower prices, which would benefit consumers, seem to be strenuously opposed by these "patriots." There is much food for careful reflection in this and similar cases.

FROM ACTUAL PRACTICE.

SYSTEM, SHOP MANAGEMENT AND BROACHES.

"MILO."

Shop work and shop management are very much like a game of checkers. It is the man who has nothing to do with the game who can always see what he thinks would be the best move to make and just where the other fellow made his mistake.

There are so many moves made in actual practice, few if any of which are original, that there is little use in trying to give credit, so will content myself with mentioning a few actual moves for the benefit of those to whom the ideas suggested may be of interest and value.

I know of two men who left the shop and went into business, and taking advantage of certain inducements offered by the town of Hardscrabble, they located there and started in with a few men to build machine tools. The first nine or ten years were years of unusually steady and prosperous business. So steady that only one man had been discharged for want of work. They had built a shop and enlarged it two or three times, and the crew had increased to about fifty men when the recent panic struck them. They had begun to look after the little leaks when I was hired into the shop, and it was easy to see that lack of system was one of the largest leaks, which was admitted by the proprietors, yet they were afraid of getting too much system.

FIG. 3.

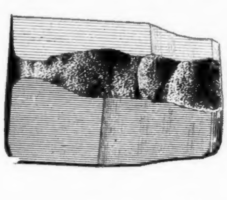


FIG. 1.

Mr. Nay was the business man of the company; one of those clear-headed, go-ahead-and-succeed sort of fellows, who leave details and system to be taken care of when there is more time to spare—which never comes. One day I was talking with him about shop tools, system and appliances, etc., and he said: "I know of a shop in this State which has a most elaborate system and has hardly made a dollar, when they might have made their business pay a handsome dividend if they hadn't squandered thousands of dollars on system."

He saw *their* mistake. Many a time I have seen his partner, Mr. Yea, or his men, hunt for hours for some tool or fixture that they should have been able to find in the dark or at a moment's notice; all for the want of a little system.

In regard to appliances, he said: "When I am off on my business trips and have a moment to spare, I usually spend it in a machine shop. The other day I discovered an item in one of my old note books about a man I saw at work in one of those finely equipped shops, and if I should see one of my men do what he did I would discharge him on the spot. He had a piece of work on the planer that he wanted to move to another machine near by, and he sat down and waited 35 minutes for the traveling crane, then it took 20 minutes more to move the piece. There was 35 minutes that he waited, 20 more to place the work, and 20 minutes also for the man on the crane; making 55 minutes to move a piece of metal that didn't weigh over 100 pounds. Any one of my men would have picked it up in his hands and carried it across the shop in less than two minutes without saying a word." What he said about his own shop I know to be true, for I did it many times myself, and there are other things that happened in his shop also.

One day Mr. Yea gave me two broaches, one of which is shown full size in Fig. 1, and told me to fit up some tool-post wrenches. The other one was about $\frac{1}{32}$ of an inch smaller, and had a shank making it about 3 inches long, and I suppose both had a shank once. Business was dull and the wrenches were to be made up for stock, which was all he could think of to be done just then.

I started to work them out as directed, but to file them out, using the broach as a sizer was slow and monotonous. Although several styles and numerous broaches had been made for the job and were failures, permission was finally obtained to try my luck at making one as an experiment (probably because I was a new man in the shop), but not until I agreed to make it on condition that I should receive no pay for my time unless I made a broach that would stand and do the work successfully. Now $\frac{7}{8}$ inch round steel would answer the purpose, although it would allow less than $\frac{1}{100}$ of an inch for centering and finish. But there was none on hand between $\frac{3}{4}$ inch and $1\frac{3}{8}$ inch, so I either had to use the $1\frac{3}{8}$ inch and turn it down or do as the blacksmith suggested, which was to upset one end of the $\frac{3}{4}$ inch steel to make it large enough; and I permitted him to do the latter, thinking that by so doing I would get it annealed. When I had given him, as I thought, plenty of time, I went down after it again, and there it was in the power hack-saw and the blacksmith waiting for it to be worn off with a blade that was about as smooth on one edge as it was on the other. When the saw had worn itself into the metal far enough so he could break it off, it was taken to the forge and upset. It was one of those shops where the blacksmith "does the work while you wait," and it took three-quarters of an hour longer than it should before he had finished work on it. Then it was too small.

But he said "I can't help that, if the company won't furnish such stock as they need, they can go without. I am not going to bother with it any more." Why didn't he take that bar of steel to the forge, upset the end and cut it off with a chisel while hot?

The boss ordered the blacksmith to give me a piece of $1\frac{3}{8}$ inch, which was cut off in the hack-saw also. I got it the next afternoon, and made it up without annealing, as usual. Talk about waiting for cranes—nobody knew about the first piece nor the time lost; it was simply charged to "making broach."

It was my intention to use the screw-press made for straightening shafting, to press the broach through, instead of driving it with a hammer, as they had always done, and $5\frac{1}{2}$ inches was the longest broach that could be used in it. I was foolish enough to think that a broach of that length would do the work; *and it did*, but not to my satisfaction, for the stock tore out on the under side, which was overcome by putting a washer under the wrench and broaching through both. I was not satisfied, and decided to try again, and made two more, which were practically one long broach like Fig. 2, twice as long as the first, having in all about 36 cutting teeth $\frac{1}{4}$ of an inch apart. In making Fig. 2 it was first turned a true taper, except the end at B, the diameter at F being equal to C, and the diameter at G equal to E, Fig. 4. The teeth were also made in the lathe, as well as the clearance on them, which is all on the rounded part of the tooth. There is no clearance to speak of on the flat milled surfaces H I J, etc., as the top, which is square, is only about $\frac{2}{1000}$ of an inch thinner from side to side than the diameter of the first tooth on the point which is round; the increase in size being from corner to corner only; so if it is started straight it will go straight. D D represents the amount of stock to be removed. The wrenches were the ordinary drop-forged tool-post wrench for $\frac{9}{16}$ inch square hole, and I put a $\frac{9}{16}$ drill through them first so as to have a hole (C, Fig. 4) of uniform size to start the broach in and enable me to use as short a broach as possible.

Now let us see how Fig. 2 will work. The point B just slips into the hole made by the drill, and the first tooth smoothes it out a little on the sides; the next tooth removes the eight little chips K K, etc.; eight more are removed by the next tooth, and so on, the last tooth smoothing out the four little three-cornered pieces S S S S, the whole operation being very similar to planing out four little "angle irons" with a feed equal to 36 chips in $\frac{9}{32}$ of an inch, and depth of chip equal to D; the chips removed resembling those made by a good tap instead of Fig. 3. The broach worked so easily that the work was done with ease on a common arbor press having a lever about two feet long. Fig. 2 was a success in every way, although it cracked the whole length in hardening.

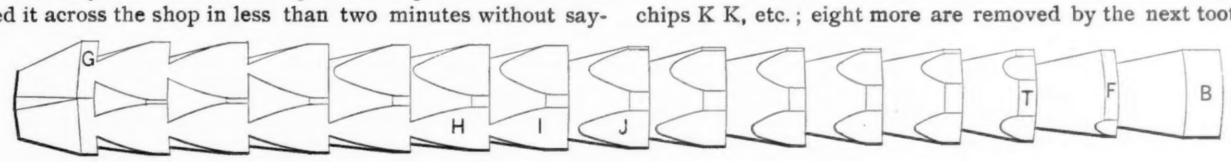
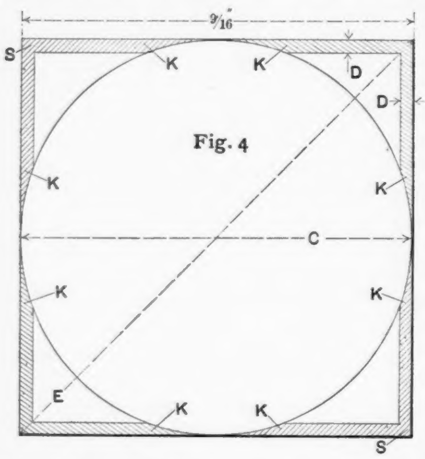


Fig 2

The first broach that I made had a clearance on the surfaces H I J, etc., which would be all right in a press with any way to hold it properly, but did more harm than good in this case, for

they had no cutting to do any more than the sides of the teeth in a square thread tap, and it increased the tendency to go crooked or work to one side, and took too much stock, causing it to tear out as mentioned.

Most men make a broach of the same shape at both ends and tapering, and the teeth cut straight or sometimes slanting across the sides; the idea of cutting them diagonally being to obtain a shearing sort of cut. I don't like either way, because the teeth present too much cutting surface to the stock, and there is no break in the chip to let it get out of the way easily. The chip crowds in from each side towards the center and against itself at the corners, where the metal is literally crushed. To illustrate, a broach $\frac{9}{16}$ of an inch square, with teeth running directly around it, would present a cutting edge to the stock equal to a chisel $2\frac{1}{4}$ inches wide, and it would, if strong enough, remove a chip similar to Fig. 3, which is a sample of the hard work done by Fig. 1.



As I have said, Fig. 2 was a success, and I was well pleased with it until one day when Mr. Nay and I were estimating the time it would take to make certain changes, he told me that "it took a long time to make that broach." "Yes, it did take a long time to make it. I made it on my own time as an experiment, so I felt at liberty to take all the time I wanted; besides, I kept one and sometimes both of those milling machines running most of the time I was at work on it. There are the wrenches done with it, better, and about five times as quick as usual, and you can find no fault with them. Here are the broaches, the first successful ones you have had out of many; and instead of one, as you thought, there are three of them, and you are not asked to pay for them unless they are satisfactory."

I could have mentioned the time lost waiting for the stock, and a number of other things which could easily be overcome by a little system, but as he claims to have the best method of keeping time in existence, I decided not to. His system of keeping time is good, and if each department was as well managed as his time keeping there would be little fault to be found with the way things are run, and better results would be obtained.

As there is always something of interest in these backwoods shops, and recent happenings indicate coming reforms, another chapter from Hardscrabble may be expected.

* * *

MACHINING CYCLE FORGINGS.—2.

ONONDAGA.

When placing the forgings into the jigs for any of the operations, it is very necessary to see that all the metal chips are removed from under the work and between the forging and the jig, otherwise the work will come out of true the same amount as the thickness of the chip that was in the way.

The jig and tools for the third operation are very much more complicated, and requires at least two drill presses at the same time if the work is to be done to any advantage, as four holes are drilled in the same forging, of two diameters, and on four different angles, without removing it from the jig. This jig is made in the form of a hollow box, of cast iron, with the bottom left open to allow the chips to drop out when the jig is lifted from its base, when changing to another hole.

As the chips from these cuts are very large and quite thick and stiff, they would interfere to a great extent with the successful operation of the tools if there was not plenty of room left for them to drop out, as they pack in so tight from the pressure of the revolving drill that it is often hard to remove them from between the forging and the inside surfaces of the jig.

A boss or lug is left on each end of the casting, into which are fitted centers that are of the proper form to fit into the hole through the forging, as shown in Fig. 5, which is a cross-section of the jig at the center, and shows one of the lugs for the tube directly under the bush that the drill revolves in.

It will be noticed the tail center of the jig has a long sleeve turning freely into the casting, on the outer end of which is pinned or keyed an index plate, so spaced that when the engaging dog is caught in any of the slots, one or another of the lugs are in position to be drilled. The inner end of the same center has an arm that answers the same as the driving dog on a lathe, and this arm engages one of the lugs that are to be drilled, and keeps the forging in the same relative position to that of the center, when the center is revolved, to bring the different lugs under the drill bushes to be operated on.

This arm is shown at A and the index plate at B in both the front and side view sketches. The other center is merely a large, heavy screw, with the one end that holds the forging made into the same form as the same end of the other center. A hand-wheel of convenient size is keyed on the outer end, and when a forging is placed in the jig the center is backed out far enough to admit the piece, then screwed up firmly against it. When the forging is turned round to drill other holes, the screw center is loosened sufficiently to allow of the change, as it will not be possible to turn either the center or forging when the screw is tight. As the smaller lugs for the rear fork tubes are on an angle side-

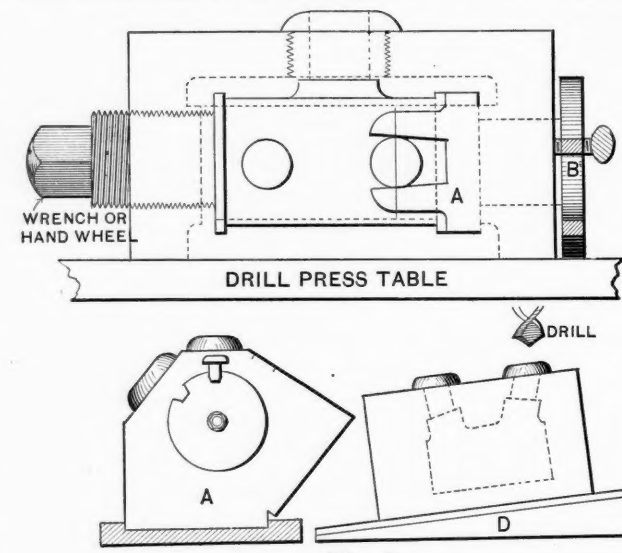


Fig. 5

ways, and the holes are to be drilled in the same jig, a plate is made that has the upper surface planed off on an angle to bring the lugs in a vertical position and in a line with the drill.

The top of this plate is grooved to fit the bottom of the jig, so the latter may slide but not turn in it when the cut is taken.

The end view of this is shown in Fig. 5 at A, which also shows the form of the end of the jig, and the location of the drill bushes. The side view is similar to D in the same sketch.

When using the jig, a forging is placed in position and the jig set in place under the drill in one of the machines; after the hole is drilled through, the index is turned round till another lug is in place and it is drilled. If the holes for the forward frame tubes are done first, these two may be drilled on the same machine, as they are generally of the same diameter. Then the jig is placed on the angular plate that has been fastened to the table of another machine, and one of those holes drilled. In order to drill the opposite hole for the rear fork it is now necessary to turn the jig end for end on account of the angle of the lugs, and it may then be drilled on the same machine as was the first lug. The reason for this is more clearly explained by reference to the sketch. The size of the drills used should be such that after the holes are done there will still be about one one-hundredth of an inch for the finishing reamers that follow.

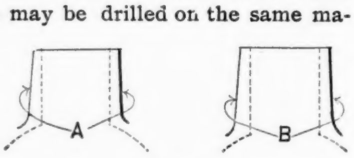


Fig. 6

This reaming is done in another very simple jig that is nothing more than a plain plate with a standard on each end into which is placed another pair of centers nearly like the first described. There is, however, no driving dog or index plate in connection with them, and they are merely tightened up on the forging tight enough to take up any looseness or play that would cause

the reamer not to follow the hole properly. The reamer is a rose pattern with a long taper shank, and has a sweep tool attached to the side in the same manner as the one used for facing the ends of the large hole in the same piece.

It not only faces the end the right length, but turns the superfluous stock from the outside, and changes the appearance from that shown in Fig. 6, at A, to the condition as at B, which leaves it only about one thirty-second of an inch in thickness at the outer edge, and a trifle more at the lower part. The same pattern of cutting tool is used in reaming and sizing the small lugs, but in connection with it must be used the angle plate as in drilling those lugs.

Unless there are holes to drill for oil cups or some other operations of the same class, the machine work is now complete, but if the forgings are fitted into the frames and brazed in the condition they are now in, there will be considerable filing that cannot be done as conveniently as if done before the tubes are in place, so the writer will describe the method he uses for removing the slight amount of metal from the outside and around the bottom of the lugs where they run out into the main barrel. If the forging has been designed properly and not too heavy, this is a very easy matter and can be quickly done with a coarse file. On account of the draft in the forging dies and the flash that is left from the dies, the forgings will not be exactly round, and as the drill did not run quite true when the holes were drilled, the outside shell of the main barrel will appear as at A in Fig. 7, being thicker in some places than in others.

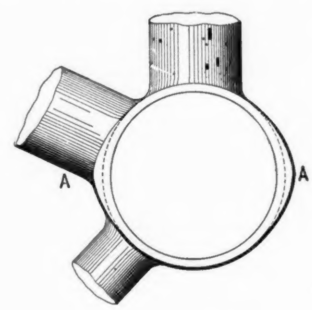


FIG. 6.

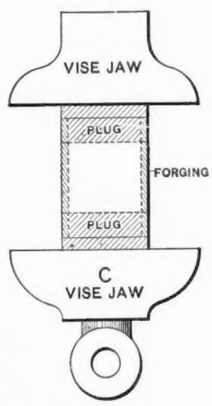


FIG. 7.

First turn up two short plugs that will fit in the hole easily, and with a head on one end the diameter it is necessary to finish the outside of the forging, then case-harden the plugs, and after placing one in each end of the forging, put them in the vise in the position shown in Fig. 7 at C, then file off the steel down to the plugs.

The corners may also be evened up in the same vise with the plugs in place, and the vise will not squeeze the forging out of shape from the pressure applied. Although the above is merely the description of the various operations on a bottom bracket forging, they are nearly the same on all the frame connections on a bicycle, and with but slight variations.

* * *

"FRICTION HORSE POWER IN FACTORIES."

Samuel Webber.

The paper on the above subject by Prof. C. H. Benjamin has led me to look up some of my old notes on the subject, to which I will refer later on. Mr. Benjamin gives the result of measures taken in sixteen different establishments, all working up iron into different forms with one exception, which is a "planing mill," and shows the proportion of the total horse power consumed by the shafting and belting, to vary from 80.7 per cent. down to 14.5 per cent., and this last one is mentioned as *exceptional*.

Now it so happens that this exceptional case, so far as machine shops are concerned, agrees very closely with my weighings of the power consumed in the large cotton mills of New England, where the machinery was compactly arranged and the shafting properly proportioned, during the ten years from 1870 to 1880, when I devoted most of my time to such weighings, and which brought me to the conclusion that between the boiler house and machinery, about 25 per cent. of the power of the steam was taken up as follows, viz., 10 per cent. in the engine, 10 per cent. in the shafting, and 5 per cent. in the belts, and if the engine friction was deducted, as it does not appear to have been done, from Mr. Benjamin's paper, it would leave 15 per cent. I should say, however, that Mr. Benjamin says in his text, referring to his Table II., that "if a deduction of 10 be made from the percentage, in column 4, they would then show approximately the power required to drive shafting and counters alone." This, I take it, means to allow 10 per cent. for the engine friction, but it should be 10 per cent. of the total power. It is not necessary to copy the whole of Mr. Benjamin's article, a portion of which was published in last month's issue of this paper, on page 139; but I will give his data relating to the two extreme instances to which I have referred. The first one, No. 4 in his tables, is a case of "Bridge Machinery," having 1 460 feet of line shafting, at 110 revolutions per minute and varying in diameter from 4 inches to 2½ inches. It had 142 bearings and drove 92 belts, averaging 4½ inches wide, with 79 counters and 69 tools. Here the total horse power, as given by the indicator, was 59.2, of which 11.3 horse power was consumed by the machinery and 47.9 by the shafting, or 80.7 per cent., and here Mr. Benjamin says: "This would seem to be one of the cases where electrical transmission would be a good investment."

The other extreme is case No. 13 in his tables, steel wood-screws, with 674 feet of line shafting, at 175 and 160 revolutions per minute, of diameters from 3 inches to 1½ inches, with 96 bearings, 89 counters and 131 4 inch belts and 392 machines.

Here the total power was 117 horse power, of which 100 horse power was taken by the machines, and 17 by the shafting. Of this case Mr. Benjamin says: "As the machinery is of the automatic type very compactly arranged, the conditions are about the same as in several other shops visited, but an inspection of the shafting shows that great care has been exercised in its construction and operation. It is in perfect alignment, runs in cast iron boxes, without babbitt metal, and supported by unusually rigid hangers, while it is oiled by hand, instead of "wick-oilers."

Now this description would conform generally to the situation as found in the large cotton mills to which I have referred, but I will quote Mr. Benjamin further, for he says "That these conditions do not always obtain, is shown by the remark made to the writer by the superintendent of one of the establishments visited, who said that he wished the test could be repeated, as after the first visit he had examined the shafting and found that one length was about 3 inches out of line!"

From the data thus collected, Mr. Benjamin draws some admirable conclusions, which, however, conform closely to modern cotton-mill practice, and which I will give at the close, noting first some of my own observations, in weighing the power required to drive shafting, with the dynamometer.

The first case I will quote is of a line consisting of 10 feet 4 inches of 2⅞ inches diameter, and 176 feet of 2⅛ inch, at 211 revolutions per minute, with 24 bearings, weight, with pulleys, 5 335 pounds. This line was weighed at 11 A. M., having been oiled at 7 A. M., and required 1.442 horse power. A similar line taken just after oiling, took 1.234 horse power.

A line composed of 10 ft. 4 in. of 4⅛ in. diam.	Weight with pulleys 9 303 HP., 26 bearings at 210 R. P. M.	took 1.587 HP.
80 " " 2⅞ " "		
32 " " 2⅝ " "		
48 " " 2⅜ " "		
32 " " 2⅛ " "		
or 202 ft. 4 in.		

Another line of 114 feet, 2⅛ inches diameter, at 216 revolutions, with 15 bearings, weighing, with pulleys, 3 225 pounds, took 0.590 horse power. A second similar line was then connected by a belt, and the two lines took 1.181 horse power. A third similar line, but with two more bearings, making 47 in all, with 342 feet of shafting, weighing, with pulleys, 9 429 pounds, took 1.858 horse power. These lines were all nearly new, supported by heavy hangers from deep beams, and fitted with Dreyfus oilers, and may be considered as a very fair average of shafting in first class order.

A short countershaft 8 feet 6 inches long, with two bearings, weighing, with its pulleys, 678 pounds, at 216 revolutions per minute, required 0.089 horse power. Four such counters, connected by belts, at same speed, with a total weight of 2 378 pounds, took 0.357 horse power.

A line composed of 9 feet, 4 inches, and 231 feet of 2⅛ inch, which was fitted with tallow cups in the bearings, and had been oiled at 7 A. M., with 31 bearings, at 211 revolutions per minute, weighing in all 5 805 pounds, tested at noon, required 1 558 horse power. The tallow was removed from the boxes at night and pieces of sponge substituted. These were oiled the next morn-

ing, and a second test at noon also, showed 1.126 horse power. Now these notes may serve to show what power shafting *should* absorb, if thoroughly put up, properly aligned and kept well oiled and in good order, lend evidence to Mr. Benjamin's conclusions, which were given last month.

It might seem superfluous to say that such rules are generally observed in the large manufacturing establishments of New England, to which my attention has been especially devoted, but such is generally the case. I regret now that I did not also keep a record of the power actually transmitted at the time by the different shafts to which I have referred, but they form only a part of the general series of measurements which included the power consumed in the mill, and in the case of the first shafts I have noted this amounted to 744 horse power. From the shafts which I did weigh, say three-fourths of the whole, I estimated, by means of the length, weight and diameter, the power required for the rest, finding the whole to be a little over 8 per cent. of the power required for the machines, which I also weighed independently by the dynamometer. This, as I have said, was a new mill, strongly built, and in perfect order, though a large part of the machinery had been previously in use.

In the case of another mill of older construction, I weighed all the machinery and very nearly all the shafting; I found the latter, calculating the rest as before, to be about 11 per cent., and in a third, new mill, where the machinery was light, or 185½ horse power, the shafting took 21½ horse power.

These weighings were for shafting only, and did not include the belts, which, as I have said, I estimate from other tests to be about 5 per cent., being on cotton machinery about 2 per cent. on the spinning frames, while as high as 10 per cent. on looms, but as the spinning takes half the power of a cotton mill, I considered 5 per cent. a safe average.

Beside the instance which Mr. Benjamin has himself noted, I find others in his tables in which it would seem economy to employ electric transmission, if the latter would utilize 90 or even 80 per cent. of the power obtained from the engine or turbine; one, for instance, where 580 feet of 3 and 3½ inch shafting was employed to drive eighteen machines, the shafting taking 77 per cent. of the power, and another where 1 120 feet of 3 inch shaft consumed 57 per cent. of the power required to drive sixty-eight machines, but I think I have said all that is necessary on this point of my subject.

My object, when I began, was to call attention to the observance of just such rules as those suggested by Mr. Benjamin, in cases where plants were already established; and secondly, where the machinery was widely scattered, either as single machines or in small clusters, over a large area, to the already established economy of electric transmission, which is now being used to great advantage in some of the Southern States, for cotton mills, where the whole power is being sent over the electric wires.

* * *

The second exhibition of motors and machine tools, inaugurated by the General Industrial Association of Munich, in co-operation with the Polytechnic Association of the same city, will open June 11 and close October 10, 1898. This is under the patronage of H. R. H. Prince Luitpold of Bavaria, and has the support of the Bavarian Governments as well as the municipality of Munich.

The exhibition comprises five groups, as follows:

1st. Motors, gas, petroleum, benzine, steam and hot-air engines, machinery driven by water and wind power, and electro-motors up to ten horse-power.

2d. Machine tools, hand tools and implements.

3d. Auxiliary machines, as pumps, ventilators, presses, cranes, clocks, parts of machines, electrical arrangements, safety appliances, apparatus, auxiliary materials.

4th. Manufacturing processes in operation, and machinery in motion.

5th. Special technical literature.

The exhibition will contain motors, machine-tools, hand-tools, implements, apparatus and machinery in motion, as well as the materials to be worked up, and the manufacturing processes in operation. Motors over 10 horse power and tools or machines requiring greater driving power, such as steam hammers, lathes, rolling-machines and the like will be excluded. Popular lectures on special scientific and technical branches will be delivered, and technical literature on these subjects will be exhibited.

HOW JOHNSON REAMED THE CYLINDERS.

F. G.

About a month ago Johnson came around one evening to "wise" a little, as we old fellows are likely to call it. The case was like this: Johnson and his partner have a rather nice little machine shop where, as times are going now, they are boss and "all hands" as well. They had received an order for twelve cast iron pipes (hydraulic cylinders); they were ten feet long, to be threaded at one end similar to gas pipe, while a short raised portion at the other end was turned for a support. They were to be smoothly bored about 10 inches diameter. I say *about* 10 inches because $\frac{1}{32}$ inch over size would make no difference.

Johnson's trouble was this: He had bored three of the cylinders 10 inches diameter, and became satisfied they would not be accepted because they were not smooth enough to suit the customer. He had bored them with an old sleeve bar that had seen its best days, and while the work was pretty fair, it was not smooth enough. Together we planned as follows: Go on with the original plan of boring the cylinders, getting them true without making much effort in the way of getting them smooth. This Johnson did, then he took a piece of 3-inch shafting that was long enough for the purpose, for a boring bar. Fitted up, the bar was like sketch, Fig. 1, in which *a* is a disc keyed near the end of the shaft, and to which disc *b*, carrying nine cutters 3 inches long was bolted. It will be noted that the slots for the cutters, two of which are shown, are planed at an angle, five in one direction and four in the other. I can give no very good reason for these slots being on an angle, except where such cutters act mainly as a reamer they seem to act best set on an angle.

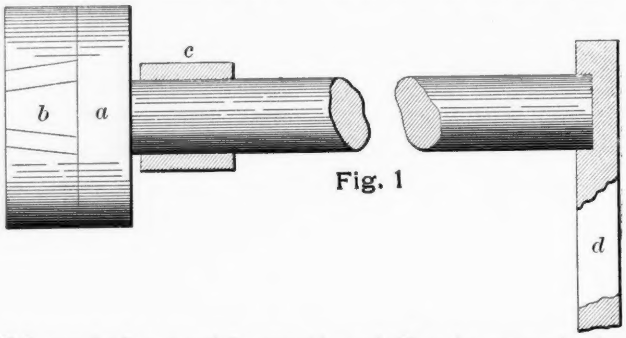


Fig. 1

Johnson had no special means for grinding the cutters in place; so after hardening them and driving them to place, the bar was mounted on the lathe centers, and a piece of stone similar to that used for a stone finish was clamped to the tool block. This was traversed by the slide rest while the bar was revolved backward, as it would be termed. A very little subsequent touching up with an oil stone put the cutters in proper condition.

The piece *c* is a sleeve about 5 inches long, that was clamped in the back rest and bored an easy fit for the improvised boring bar, remaining in its position till the job was completed. The piece *d* was made with a shank like a lathe tool, so as to fit the tool post, and feed the bar. A large wooden pulley was then fitted over the upper feed pulley to obtain coarse feed. A piece was held in the lathe chuck and threaded to fit the threaded end of the cylinders. For a back rest for the other end, a couple of wooden blocks were suitably gouged out, one of the pieces of wood bolted to the ways and the gouged out holes were babbitted. The holes in the cylinders were enlarged $\frac{1}{64}$ inch, and instead of being a little wavy, as we had feared, were about as smooth as holes could be made.

I am not advocating this as the best way of arranging for the boring of a large number of similar cylinders. I only say that it was a cheap and very satisfactory way for Johnson to get out of what was becoming a troublesome job to him. His little shop was not burdened with many of the appliances of the large modern machine shop, but he made a job of those cylinders that he was inclined to feel proud of.

In the sketch no attempt has been made to locate the angle of the cutter slots, or their relative positions. If I were to recommend anything further it would be that the angle of each slot be different.

* * *

Don't put a new file on rough work at first. This advice is older than Methuselah, but is necessary as long as men persist in doing it. Use an old file first on the scale of castings or hard forgings.

LATHE CONES AND BACK GEARS.—2.

R. E. Marks.

Having found the diameters of the steps of lathe and countershaft cones to be 4, 6.02, 8.02 and 10 inches diameter each (as they are similar cones in this case), and the feed cones to be:

Driver, on Stud................. 2 — 3.23 — 4.36 inches.
Driven, on Feed Rod.......... 7 — 6 — 5 "

we can now talk about speeds.

The question of back-gear is often a puzzling one, because the one who is puzzled jumps at conclusions or overlooks some vital point. In engine lathe work, 120 revolutions would be altogether too fast for a large part of the work, and it is usual to use the back gear as a means of still further reducing the speed; but, this is not the only reason. It is not often that an engine lathe runs at its highest speed, as the work is usually of iron or steel and requires slow speed, and the question is sometimes asked, "Why not run the countershaft at a slower speed?" This is best answered by refering to the fact that the power of a belt depends primarily on its speed, as shown clearly by W. L. Cheney in his article, The Wide Belt Heresy, in the issue of September, 1896. Mr. Grimshaw, to the contrary, notwithstanding, the width being useful simply because it increases the cross-section and the belt will, therefore, stand more strain or tension. In our case we have a 10 inch step on countershaft cone (or 31.416 inches in circumference), and at 300 revolutions per minute this makes 9424.8 inches or 785.4 feet per minute, or approximately 1 HP. per inch of width. On the slowest speed of lathe the driving step of countershaft cone is only 4 inches in diameter, or 12.56 inches in circumference, and at 30 revolutions gives 3768 inches or 314 feet per minute, giving less than half the driving power on the fastest speed.

Assume that the slowest speed that will ever be required is about 12 revolutions per minute, and that we will make our back gear 9 to 1, or in other words, when the back gear is thrown in, the lathe spindle will turn one-ninth as fast as the cone, for the cone turns at the same speed regardless of whether the back gear is thrown in or out.

If the Editor will reproduce the cut he used in answering question No. 4 of the September issue, it will make this clear to those who may not have seen that issue. The pinion E is keyed to cone and drives gear D and shaft C, this carries pinion B keyed to it, which in turn drives gear A and lathe spindles. Calling pinion E 3 inches in diameter at pitch line (and of 10 pitch, giving

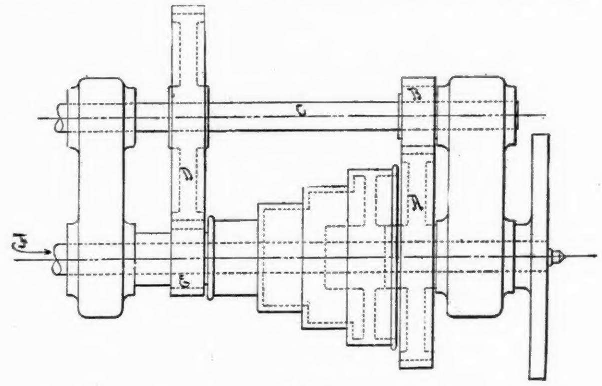


FIG. 3.

it 30 teeth), and gear D 9 inches pitch diameter, or 90 teeth, then shaft C will turn $\frac{1}{3}$ as fast as lathe cone. Repeat this operation at the other end and we see that the gear A runs $\frac{1}{3}$ as fast as C, or $\frac{1}{9}$ as fast as E, or is back geared at a ratio of 9 to 1. This is a very common ratio for an engine lathe of this size, and we will adopt it for the present, at least.

This gives our speed for the largest cone, with the belt, as 9 x 12 or 108 revolutions, and figuring this up to the countershaft cone we find by proportion 4 : 10 :: 108 : 270 the speed of countershaft. It is simple proportion now to find the lathe speed for all charges of belt, as we know the speed of countershaft. This gives us speeds of 108, 202.6, 359.7 and 675 revolutions per minute without the back gear. Dividing by 9 gives the speeds with the back gear, which are 12, 24.5, 39.9 and 75 revolutions per minute. This gives a very complete series of speeds which increase very regularly, giving a range of from 12 to 675 revolutions per minute. Where a lathe is to be used for turning only, and not for drilling, tapping, etc., as in the repair shop, there is no need for such a range as this, and when we advance far enough to make and use lathes as lathes only, and not as whole machine shops, we will probably see two step cones instead of four or more.

There are other methods of determining the correct diameters of cone pulleys, which are called graphical on account of being drawn out instead of calculated. One of these, which was shown in a paper before the A. S. M. E. by Mr. C. A. Smith, is being used to some extent and is worth looking into.

Lay out the sizes of one cone, as for example, the one on the left or larger one, which has three steps and one size of the other cone. Draw a line from the known diameter of one pulley to the corresponding diameter of the other. Lay out the distance bes tween centers, and half-way between them erect a perpendicular, as shown. From the intersection of the center line between the pulleys and the perpendicular, measure off a distance equal to .314 x the center distance C. From this point draw a circle which just touches a line drawn from the known diameters. Then, drawing lines from the known diameters of the one pulley just

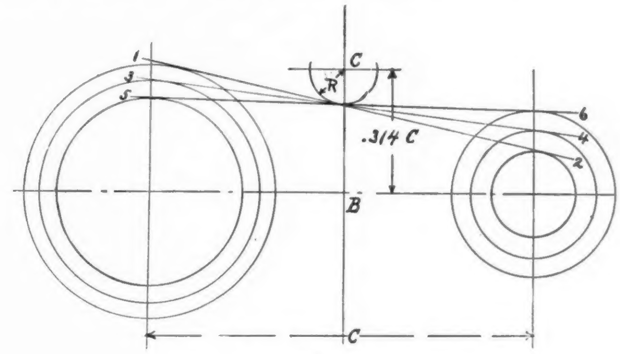


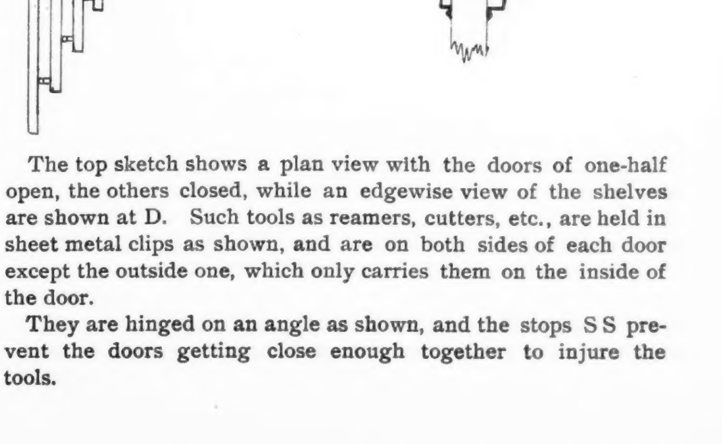
FIG. 4.

touching the circle, or tangent to it, to a short distance beyond the center line of the other pulley. Draw circles touching or tangent to these lines, from the other center, which gives the unknown diameters of the other pulley. Referring to cut, we have lines 1 to 2, 3 to 4, 5 to 6, which, it will be seen, comply with these directions and which are easily followed. It allows a chance of quite a variation unless drawn full-size, and even then, is not as desirable as the method of calculation given by Mr. Cheney.

* * *

A COMPACT TOOL CLOSET.

The tool-room of the injector department of Wm. Sellers & Co., Philadelphia, Pa., is very small for the tools it must contain, which is too often the case with tool-rooms generally, and economy of space is a very important item. The tool-closet shown in the accompanying sketch, was designed by Mr. Strickland Kneass, who has charge of the injector department here, and is the most compact affair the writer ever saw.



The top sketch shows a plan view with the doors of one-half open, the others closed, while an edgewise view of the shelves are shown at D. Such tools as reamers, cutters, etc., are held in sheet metal clips as shown, and are on both sides of each door except the outside one, which only carries them on the inside of the door.

They are hinged on an angle as shown, and the stops S S prevent the doors getting close enough together to injure the tools.

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THIS PAPER HAS THE LARGEST CIRCULATION OF ANY PUBLICATION IN THE MACHINERY TRADE.

FEBRUARY, 1897.

CONTENTS:

SEVERAL months ago we took exception to some glowing reports of the Weir-Harden compound locomotive, and were informed by the promoters that it was giving excellent satisfaction. Our own reports from that vicinity did not agree with this, and said further that it was then having a new boiler put on to enable a higher pressure of steam to be carried. Preferring, however, to await further developments, as we do not intend going off "half-cocked," or making statements without a fair basis for proof, we did not reply, but have been watching developments in the meantime. We are informed that since the advent of the new boiler the principal occupation of the engine in question has been holding down the rails outside the roundhouse, at Ludlow, Kentucky. Whether the ivy and moss have yet grown over it we are not informed.

If this locomotive was a great success with its old boiler, it is surprising that the management of the road should be so negligent of its stockholders' interests as to allow such an efficient money saver to miss a trip. Nearly all the schemes of this kind which crop out at intervals are laid low by the hand of time, and if let alone for a few months they can generally be found in a back corner or in the scrap heap, where they belonged in the first place.

And yet the promoters of such impracticable schemes as these seem to have no difficulty in securing the necessary capital to build engines or other machines, which do everything but fulfil guarantees.

THE METRIC vs. DECIMAL SYSTEMS.

The friends of the metric system of measurement are attempting to have Congress pass a bill making the use of that system compulsory, which is being opposed by most of the practical engineers and machine builders. Without considering the merits of the case at all, a sense of justice makes one oppose the compulsory adoption of any new system, no matter how beneficial it might be. The good sense, both mechanically and commercially, of our machine builders, can be depended on to use the system of measures and weights which best suits their needs, without the aid of Congress or anyone else. The metric system has several defects, one of which is that the millimeter (.03975 inch) is altogether too large for fine measurements, while to divide it into tenths or hundredths would be virtually saying "one one-hundredth of a thousandth of a meter," a very clumsy expression, to say the least. Its base is an arbitrary length, assumed by French scientists; and while it may be just as good a standard as any other, would it not have been better to have assumed something that the world was familiar with? As Sir Joseph Whitworth is reported to have said: "If we must have the metric system, call the meter 40 inches and let it come." Make the standard something we are familiar with, and the sub-divisions are a secondary matter.

The decimal system of measures, however (not necessarily the metric system has much to commend it, and if one could be devised which would not materially disturb existing conditions, it would probably be received with more or less friendliness, according to the amount of calculating done by those considering the question.

The French meter is as much an arbitrary unit as our inch, and one could be replaced, if destroyed, as easily as the other; while the inch has the advantage of priority and extended use, having been, it is stated, used in building the Egyptian pyramids.

Though many seem to cling to the "two-foot rule" with an almost idolatrous fervor, the inch can be called the real unit, and is used much more than the foot; and, when deciding on a unit for a decimal system, the inch seems by far the most suitable, for with this as a base it is an easy step to make a foot of 10 inches, with none of the useless additional measures of yards, rods, perches, poles, etc., which puzzle the school-boy and are rarely used afterward; and all quantities up to miles can be readily expressed in feet. As our mile is also a well established distance, it might be well to retain it, which would only necessitate calling the mile 6 336 feet instead of 5 280, as at present, one being as easily remembered as the other.

Changing the weighing system would be more difficult to accomplish without creating greater disturbance than in the measures first mentioned, but the pound and ton (avoirdupois) are too well fixed to be disturbed, as the inch and mile seem to be. There should of course be but *one* pound, the troy and apothecaries' weights are so evidently a relic of the past that no discussion concerning them is necessary. Let the grain be one thousandth or one ten thousandth of a pound, probably the latter; and the ounce one-tenth of a pound. The ton of 2 000 pounds furnishes the only required measure for extremely heavy weights.

Liquids present another difficulty, as our present standards are "betwixt and between" anything that common sense would have dictated. Adopting 10 pounds of water at its maximum density (39.1 degrees, with barometer at 30 inches) as a unit, and we have 315.7562 cubic inches to a gallon, which is near enough to 315.75 cubic inches for ordinary calculations and gives us about as near even figures as seems possible without departing too widely from existing standards.

When it comes to wire and similar gauges, we find an array which is enough to stagger one who is looking for

rational ideas. They are said to be laid out from curves which are parabolic, hyperbolic and spasmodic, principally the latter, if we can judge by looking at the various sizes. It would seem as though a wire and sheet metal gauge could be adopted which would be both sensible and intelligible to any mechanic, by dividing the inch into one, or possibly ten, thousand parts and making one part No. 1, three parts No. 3, etc. If we adopt thousandths as the basis, as seems most rational, then any mechanic would know that No. 10 wire or sheet was ten one-thousandths of an inch thick, without consulting a table or guessing with a wire gauge. There is no reason why this should not apply to machine screws as well and do away with the uncertainty as to what the size of a No. 14 screw really is.

It will probably be said that the plans outlined are all compromises instead of radical departures on an even more rational basis, and we must admit the truth of this argument. But engineering is made up of compromises between conflicting conditions, and we are seldom able to follow the lines we desire without many modifications. The proposed changes involve comparatively little expense, especially in the cases of linear, square and cubic measure, which are probably used fully as much as the others. We do not believe that the adoption of the metric system would be of sufficient benefit to warrant the expensive changes and confusion, nor do we think it desirable to abandon our established units in many cases.

But whatever changes we think it advisable to make, we should abandon the idea of compelling people to adopt them, and depend on the good judgment of those directly concerned to use whichever system was best adapted to their needs.

* * *

HERE AND THERE.

TESTIMONIALS.

Mr. Editor:—Just about two weeks ago the Old Man sent me over to the landing to look after Stryker's engine. Wasn't anything in particular the matter with the engine that a good engineer wouldn't have made as right as could be, some night before going home to supper, three months before; but Stryker don't hire that kind of an engineer. Such an engineer wants money for what he does, and some consideration for what he knows, and Stryker's idea is that he don't have much to do anyhow, and don't need to know how to do anything but shovel coal and open the throttle.

Stryker's plan makes it real good for us machinists, and yet you'll see a real intelligent machinist who is sent out on a job, even when he finds a couple of weeks' work that an hour's time, during the last six months, might have saved, go around the first corner he comes to and kick himself, all about an engineer who served his time making bricks or something of the sort. And the more intelligent, in other ways, that machinist is, the more he'll kick himself because lots of work is thrown right in his way. Stupid engineers just keep him in overalls, jumpers and pocket-rules and other necessities, and he never seems to appreciate it, like.

While I was puttering up Stryker's engine, just the best kind of a talker you ever saw came along with a patented arrangement for distributing steam under the grate bars. "Patent" was all the way the thing was done, of course. Lots of mixers, but they didn't mix scientifically. Well, now, that fellow could tell you more about the saving of coal by mixing gases you never heard of, than would fill all the pages of this paper for three or four numbers. Must be mixed by *that* mixer—to be sure. Just fairly got pathetic; worked your sympathies way up, he did, when he told you of the sad condition of those chaps who had contrived to scratch together some kind of a living by owning coal mines and controlling transportation; told you of their real condition when that mixer got fairly let loose.

I was a little interested in all this, because when the Old Man brought out his new engine he really believed it wouldn't use much steam, anyhow, and he got in lots of boilers too small for the work. A good deal of trouble was experienced with some of these boilers. I didn't believe so much in the mixer's talk, but when he spread right out before me about forty pages of printed testimonials—most of them from well-known manufacturers—there didn't seem to be mucn room for argument. Must be just the thing for the Old Man's weakness for small boiler capacity.

I gathered up a pocket-full of documents, mostly testimonials, and when I got back I opened up the case to the Old Man. He listened a little, then he broke out:

"John," said he, "do you know anyone who's saved half his coal and made more steam than he wanted by squirting steam under his grates?"

I had to admit that I didn't know from observation. "But just look at these testimonials, some of them from the best houses in the country. Why, here's one from Goe and Starte; couldn't keep steam an hour without it; and so they go."

"See here, John, when you struck me for a job why didn't you unload a pocketful of testimonials, all about your superior ability, and all that."

"Because I don't believe in them for a workingman. His work right along, day after day, is all the testimonial he needs, and all that'll do any good. Testimonials wouldn't have done any good."

"Just what they wouldn't. Shouldn't have read a blamed one of them. When you get where you've got to buy things to run a machine shop with, just as I have to do, you'll know a lot more about testimonials than you do now, and you'll wish you didn't know more than half as much. Good things for patent medicines and the like; seem to fit right in. But when you come to this kind of business they won't work, and that's all there is of it. Why, man, you can get just any kind of a testimonial you want from a good-natured sort of a man. Write it right out for him and he'll sign it to get rid of you. Testimonials come real cheap.

"There's the way the thing goes," taking down a bound volume of *The Beacon Light of Engineering*. "I marked these two places ten years ago, and it's just the way the thing goes to-day. Now, you read this, and then that." *

The first article was a letter from one of those bright fellows who tramp around selling supplies to the unwary. It was written from a southern city where there was on exhibition a real, new steam engine. This the salesman, according to his letter, "actually looked at, and slid out of the alley door, fearing I would be called on for a testimonial. I did not want to refuse this for business reasons of the house I am connected with, and on the other hand did not want to write myself down an ass, which was a real good reason as far as I could see."

He didn't get away, though. In a few days the party exhibiting the engine wrote him, ordering some supplies and a testimonial. "Just put it all in one order to save space and misunderstanding." This he gave, so he says, "in as mild a form as possible." "Had to do something, of course, because there was the supplies part," the Old Man says. Then he gave an account of the engine, as told him by some other fellows, and quite rattles himself loose to make fun of the engine, test and all. "The whole thing is very amusing to me," says he, "and I suppose it would have been so now, if the fellow who set up nights getting his ideas into that engine had not got his innings." That was in the second letter the Old Man showed me.

"Wouldn't have asked him for a testimonial," he writes, "if he hadn't bragged the engine up just before he made that 'slide out of the alley.'" Regarding the testimonial, he says: "I ask for no better;" here it is:

"Having seen the oscillating engine exhibited by you in this city, will say that it is a very simple piece of machinery, having but few parts to get out of order; and I have no doubt that it can be used with success in quite a large number of cases."

"Then," said the Old Man, "that isn't quite so strong as the testimonials you've got here, because the party who owns the engine didn't write it himself or set his best clerk at the job; but that's about the way the testimonial business goes. I'll show you, just for a lesson you ought to have. Going to write Goe & Starte, just to say I've heard they have got one of these mixers in use, and ask them how they like it. They have forgotten all about this testimonial six months ago." In a few days after, he showed me the following:

Jacobus Bildmake, Esq.

Dear Sir:—Your favor 21st inquiring how we like the Scorcher Mixer at hand. We had one put in about a year ago, but it was out of order most of the time and our engineer said it cost coal to keep it going, so he threw it out in the yard after a month's trial.

Yours truly, Goe & Starte.

P.S.—Bill of goods you ordered will be shipped to-morrow.

* The above is a record of actual occurrence.—J. L.

The Old Man was triumphant, and I had to allow he had a right to be.

Mr. Editor, I haven't a word to say against steam under the grate. It may be a real good thing, and there may be some real good ways for getting it there for all I know; but when it comes to testimonials, I shall advise anyone wanting them not to take them second-handed. Don't look as though they amounted to much, anyhow. If I built just the best steam engine, or the best apple-parer in the world, I'd publish, right in my catalogue, a list of a few parties using them, and let every man I was persuading to buy, write for his own testimonial.

Yours truly,

JOHN LOOKABACK.

* * *

EXTRACTS FROM A. S. M. E. PAPERS.—2.

CONTRACTING AND DEFORMATION OF IRON CASTINGS.

The author of this paper, Mr. Francis Schuman, Philadelphia, Pa., has had the opportunity for a wide observation in this line, and his experience and conclusions, which extend over a period of twelve years, are interesting and valuable. The following general laws are advanced concerning the subject:

"Cast-iron, as well as other bodies, with but few exceptions, expands or contracts equally in all directions, with the increase or decrease of its temperature, respectively. Hence the proportions of a body, whether its temperature increases or decreases, remain alike. At moderate low temperatures, from 32 degrees to 212 degrees Fahr., the change is directly as the temperature. At high temperatures the changes are greater than the changes in heat.

Contraction takes place just when incandesence disappears, or when the color changes from red to black, and continues until the temperature is normal to that of the surrounding mediums.

CONTRACTION AND DEFORMATION OF PRISMS CAST IN SAND MOULDS.

A prism cast in a sand mould will maintain its alignment, after cooling in the mould, provided all parts around its centre of gravity of cross section cool at the same rate as to time and temperature.

Deformation is due to unequal contraction of the cross sec-surrounding the centre of gravity of the piece.

Unequal contraction is due to unequal cooling, causing, or tending to cause, initial stresses in the elements of the prism, resulting in deformation or rupture.

The rate of contraction between the fluid (heated) state and the solid (cold) decreases with the volume or mass of the casting, and inversely as to time of cooling.

Rapid cooling tends to increase the density of the iron; the crystals are diminished in size, and the fracture denotes greater compactness, with more evenness of surface and less ruggedness. The color tends towards white, denoting a change of carbon into the combined state at the moment of solidification. The size of crystals decreases with an increase in combined carbon. Its resistance to impact is lessened, and the rate of contraction is increased.

Slow cooling develops larger crystals, less density, and increased ductility. The fracture is darker or more gray in color, the surface uneven and rugged, and the carbon is in a more free state. The contraction is lessened, and the casting has greater resistance to shock, although its resistance to a quiescent cross-breaking force may be less.

In any prism, variations in density may occur by reason of differences in the rate of cooling, the more rapidly cooling part being more dense, made so by the molecules drawn from the still fluid part of the casting which, cooling later, will be less dense or with a diminished number of molecules. The molecules in adjusting themselves follow and flow in lines coinciding in direction with the waves of cooling, being from a high to a lower temperature, thus tending to create a void and lessening the density of those parts which cool slower.

The rate of cooling, or dissipation of heat, is uniform around the perimeter of the cross section.

The total amount of heat to be dissipated per unit of perimeter of section may or may not be uniform or equal, depending upon the character of the cross section.

The greater the amount of heat to be dissipated per unit of perimeter, the slower the cooling.

The amount of heat to be dissipated per unit of perimeter varies in proportion to the volume or mass of the prism of which the respective unit forms the dissipating side.

The relative amount of heat dissipated in a prism, per unit of time, varies in proportion to the dissipating surface of the perimeter divided by its respective volume of cross section.

The crystals that form in cast iron, when changing from the liquid to the solid state, have the tendency, when no disturbing causes interfere, to form themselves into regular octahedrons, or double four-sided pyramids, with their bases joined.

Their size varies, the mean increasing with the slowness of cooling. The long axis of the crystals tends to adjust itself perpendicular to the plane of cooling surface of the casting. Thus, in a cylinder the axis would coincide with the radial lines, while in a square prism, the axis of the crystals being perpendicular to the four sides, will tend to flow apart on a plane bisecting the angle of two sides; on this bisecting plane the casting will be less dense and of diminished cohesion.

A prism, unsymmetrical in section, in which the proportion of cooling surface to mass varies around the centre of gravity of the cross section, will have the greatest porportion of smaller crystals in the parts cooling the quickest. Where the change in the rate of cooling is greatest will be the place of greatest interference to the natural adjustment of the crystals, as to size and position, and hence the place of least cohesion.

Contraction is in a direct relation to the rate of cooling and size of crystals. The more rapid the cooling the smaller the crystals and the greater the contraction.

In any prism, unsymmetrical in section, composed of a smaller mass joined to a larger, the greatest longitudinal contraction will occur in the smaller mass. This apparent contradiction to the general law, that contraction decreases with the mass and rate of cooling, is explained when we consider volumnar contraction. The larger mass will have its rate of contraction equal in all directions; the smaller mass is restricted in its contraction longitudinally by the larger mass at the point of juncture of the two masses, but maintains its greater rate of contraction transversely; were the transverse rate the same as that of the larger mass, its longitudinal contraction would be the same, but its adverse rate being greater, the excess in volume flows in direction of length, resulting in a greater length, after cooling, of the smaller mass.

Modifying causes that affect the results obtained by the application of the preceding laws are: Imperfect alloying of two or more different irons having different rates of contraction; variations in the thickness of sand forming the mould, which is the medium for conducting the heat from the surface or perimeter of the cross section; when the prism is cast in a horizontal position, and thin layers of sand at top and bottom affect the dissipation of heat, which becomes unequal by reason of the difference in circulation of air between the upper and under external surfaces of the mould, the upper surface dissipating the greater amount of heat; the position and form of cores, which tend to resist the action of contraction, also the difference in the conducting power between moist sand and dry-baked cores; differences in the degree of moisture of the sand surrounding the prism, especially when small in mass; unequal exposure by the removal of the the sand while yet in the act of contracting; flanges, ribs, or gussets that project from the side of the prism, of sufficient area to cause the sand to act as a buttress, and thus prevent the natural longitudinal adjustment due to contraction; in light castings of sufficient length the unyielding sand between the flanges, etc., may cause rupture.

INFLUENCE OF THE PRINCIPAL CONSTITUENTS OF IRON UPON THE RATE OF CONTRACTION.

Carbon is the most active element, when in the combined state, to increase the rate of contraction. As strength and hardness result from slight increase in the proportion of combined carbon to that in a free state, it follows that strong irons have a greater rate of contraction than those in which a lesser amount is present. When the combined carbon exceeds certain limits, hardness and contraction increase rapidly and the strength decreases. Increase in the proportion of free carbon has the opposite tendency.

Silicon, when present, not exceeding certain limits, tends to free the carbon, reduces the rate of contraction, and increases the ductility and softness of the iron. Increasing the silicon up to, say 10 per cent., causes the iron to become brittle, hard, and weak, and increases contraction.

Sulphur tends to change the carbon into the combined state, and hence increases the rate of contraction.

Phosphorus, while tending to harden the iron, has little, if any, influence upon the proportion of combined to free carbon. It lessens the rate of contraction and diminishes the strength of the iron.

Manganese, as usually present in foundry irons, about 1 per cent., has no appreciable effect. When, however, it reaches 1.5 per cent., and the iron is low in silicon, it tends to hardness and increases contraction, although no alteration in the carbon is affected. In some hard irons the combined carbon is lessened as is also the contraction, by adding small quantities of not exceeding 0.15 per cent. of manganese to the molten iron in the ladles just before pouring in the mould. Increased strength also results.

Repeated remelting increases the rate of contraction; it tends to harden the iron and increases its density. Originally soft mixtures become stronger and harder, while hard mixtures become harder; the proportion of free carbon decreases and the combined increases; the total carbon is slightly decreased. Silicon and manganese rapidly decrease, phosphorus to a less extent, while sulphur rapidly increases, due to the fuel.

The cross-sectional area of test pieces for determining the rate of contraction of a given mixture of iron should increase with the increase of combined carbon contained in the mixture, when intended for large castings.

Then followed an exhaustive determination of the rate of contraction by the aid of complex formula and higher mathematics, which will not be nearly as useful to the readers of this paper as the portion given.

STEAM ENGINE GOVERNORS.

The general conclusions on this subject, with which the author, Mr. F. H. Ball, is so familiar, are both interesting and instructive.

First. Centrifugal force is the most important governing force, because it is indispensable.

Second. Angular accelerating force is next in importance, because it is an unqualified help as an actuating force, and its practical usefulness is limited only by constructional considerations.

Third. Tangential accelerating force is of questionable utility, because of the disturbing forces that it is almost sure to put into operation.

Having investigated the several governing forces and their relations to each other, the question of their practical application naturally follows. The advantages of developing all the forces in a single moving piece have already been referred to, and probably will not be questioned. Fig. 14 represents a governor wheel in which is pivoted a mass M, so as to be acted upon by centrifugal force and by angular accelerating force, and it may or may not be actuated by tangential accelerating force according to the location of the center of gravity. If the center of gravity is located at *g*, tangential accelerating force is inoperative to produce pivotal motion.

Angular accelerating force is a prominent force because of the distribution of the mass relatively to its center of gravity, and with the direction of rotation indicated it supplements centrifu-

Fig. 14.

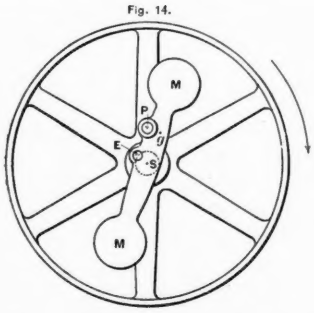
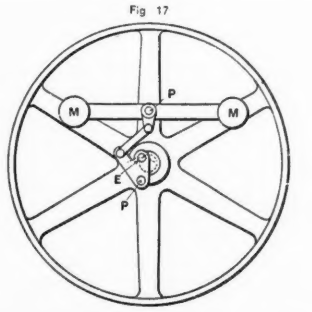


Fig 17



gal force in producing rotation about the pivot. It is possible also, with the construction shown in Fig. 14, to attach to this single moving part the stud or eccentric which actuates the valve, in which case it must necessarliy be located between the shafts S and the pivot P and E.

A centrifugally acting spring attached to this pivoted mass completes the governor, which is certainly a model of simplicity. Unfortunately, however, the location of the pivot with relation to the eccentric stud E and shaft S is not such as to give the most desirable steam distribution, although it accomplishes the function of governing,

Referring to Fig. 15 let the larger circle represent the path of the eccentric or stud when cutting off at three-quarter stroke, and let the smaller circle represent the path when cutting off at zero. Let the line A C be the path of motion which results in shifting from zero cut-off to three-quarter cut-off, without any lead. Let B be the location of stud necessary to the desired amount of lead, then the path of motion will be from B to A.

With the pivot at P the path from B to A will be the arc of a circle whose center is at P, and it is the effect of this arc that will have to be investigated.

First let it be borne in mind that with single valve automatic engines, and particularly with high speed, it is not possible to get an indicator diagram with a good steam line without a certain

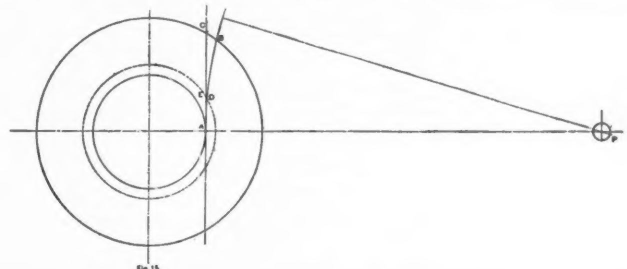


Fig. 15

amount of lead, or port opening when the crank is on the center. In Fig. 15 the distance from C to B represents the lead. It must also be borne in mind that zero cut-off cannot be obtained unless the line B A joins the smaller circle at A. Therefore the point B is fixed by the necessities of the case and also the joint A. Between the points the line may be straight or may curve on either side of a straight line.

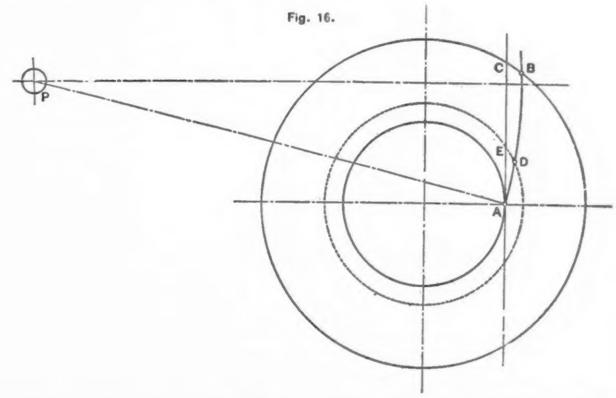
In Fig. 15 because of the location of the pivot P, the line B A curves toward E, but in Fig. 16 because of the change of location of pivot P the line B A curves away from E; therefore in Fig. 16 the lead at the points of cut-off between zero and three-quarter stroke will be greater than that in Fig. 15. Both these diagrams represent an example taken from practice, and both examples are taken from a valve gear with 4-inch valve travel, and with the latest point of cut-off at three-quarter stroke. The dotted circle in both cases represent the path of the stud or eccentric when cutting off at quarter stroke.

Taking the actual measurement, it appears that with a lead of $\frac{3}{16}$ inch at C B in Fig. 15 the lead of E D is only $\frac{1}{32}$-inch as against $\frac{3}{32}$-inch in Fig. 16.

This of itself would give the better steam distribution to Fig. 16; but this is not all, for it appears from these diagrams that when cutting off at quarter stroke, the width of port opening in Fig. 16 is about 30 per cent. greater than in Fig. 15.

This increased port opening in Fig. 16, and its better lead as already explained, produces a marked effect on the indicator diagrams in favor of the location of pivot shown in Fig. 16. To locate the pivot as in Fig. 16 it is necessary that the stud at E

Fig. 16.



should be attached to another moving part and connected with the centrifugally moving mass so as to reverse the direction of pivotal motion. Such an arrangement is shown in Fig. 17.

This construction necessitates the addition of a second moving part, and therefore adds something to the cost of construction, so that it becomes a question of choice between the cheaper construction of Fig. 14 with the less perfect steam distribution, and the more expensive construction of Fig. 17 with its better steam distribution. This comparison has been made with both mechanisms in position for cutting off at quarter stroke, but at earlier points of cut-off the difference is still more noticeable.

In view of the fact that single valve automatic cut-off engines are at best rather faulty because of the wire drawing of steam through contracted valve openings at early points of cut-off, any arrangement that adds 30 per cent. to the opening for steam is a matter of too great importance to be neglected, even for the sake of considerable saving of cost.

A METHOD OF DETERMINING SELLING PRICE.

Mr. H. M. Lane, president of the Lane & Bodley Co., Cincinnati, O., begins his paper on the above subject with the following terse paragraphs:

"In business it is necessary that both ends meet, and desirable that they overlap. To accomplish this, receipts or value produced must exceed expenditure. It is customary to transact business for a year, and then ascertain the result from the records, at a time when it is too late to apply remedies which would affect the result of that year. A ship bound from New York to Southampton has her course predetermined, and from daily observations her actual position is compared with her previously determined course, and the alteration necessary to bring her to her proper course is made at once. The captain does not sail for Southampton and wait until he arrives (somewhere) to learn how much he has missed it.

It is the purpose of this paper to propose a method by which the conditions affecting the final result of a year's business may be shown in a simple manner at the end of each month or week. It is in no sense a substitute for the usual bookkeeping and inventory, but an auxiliary for the convenience of the manager relating to organization and operation."

He outlines an annual estimate, based on past experience and judgment, to be made into a table showing the estimated expense of each department either monthly or weekly, and leaving a space below for the actual expenditures for the same period.

This also shows the estimated profit and loss which enables the manager to see at a glance whether the selling price is high enough to make both ends meet; whether certain departments are using more money than formerly; where the greatest savings have been made, and, in fact, gives the manager an idea of the efficiency of his plant without waiting until the end of the year, when it may be too late to save it from the sheriff.

A number of suggestions are given in this paper, among them being that:

"In case of a machine-shop with tools varying greatly in size, value, floor space occupied, and power required, there should be a separation of the charge for the workman and for the tool. The hourly charge for a man at twenty-five cents working on a $5,000 horizontal boring-mill should not be the same as for the same priced man working on a $300 lathe.

Answering the proper objection, that selling prices are not made by ascertaining the value of material and labor and adding a percentage, but by competition, it is nevertheless true that unless the value of material and labor will admit of the addition of the percentages proved to be necessary by the annual estimate, without making the selling price so high as to keep the goods out of the market, then the end of the year will show a deficit. When it is found that a selling price arrived at by this method is too high, the obvious remedy is to reduce the amount (not necessarily the rate) paid for labor or material until they will bear the addition of the necessary percentage without throwing the article out of the market. It is clear that, other things being equal, twice the producing force will require but one-half of the percentage to be added. It is also clear that a reduction in the total expenditure, or an increase in any items of receipts, will reduce the percentage necessary to be added. This gives the manager a definite method of making readjustments, as he obtains results of actual business as the year advances."

EFFICIENCY OF THE BOILER GRATE.

This paper by Wm. Wallace Christie, was extremely interesting and the data collected should prove valuable, the stationary land boilers being the only ones considered. The conclusions are drawn from 108 boiler tests, made by various engineers, and presumably accurate—the averages probably represent present practice.

The consumption of 13 pounds of coal per square foot of grate surface was the most economical rate found, and a few other averages follow:

Pounds of coal per horse-power developed per hour........	3.64
" " combustible " " " "	3.04
" " coal burned per square foot of grate per hour....	18.16

Taking 4 pounds of coal per HP. hour and dividing 13 by 4 gives 3.25 HP. per square foot of grate, with anthracite coal. For bituminous coal, with 23.8 pounds as the economical rate, it gives 5.95 HP. per square foot of grate.

CHIMNEYS.

Deductions from these tests give the following empirical rules which may be of interest. The constant 1.83 was the average of these tests.

Grate area $= A\sqrt{H}$ for anthracite coal (1).

" " $= A\sqrt{H} \div 1.83$ for bituminous coal (2).

Pounds of coal burned per hour $= 13 \times G$ (3).

Horse-power of chimney $= 3.25\, A\sqrt{H}$ (4).

$A =$ area of smallest section of flue in inches.

$G =$ grate area in square feet.

$H =$ height of chimney in feet.

For a chimney with 48-inch diameter or 43-inch square flue by 100 feet high, we should have by the above rules the following:

Grate area for anthracite coal, 126 square feet.

" " " bituminous coal, 69 " "

Pounds of coal burned per hour under boilers, 1,638 pounds.

Horse-power of boilers for chimney, 410.

Kent's table gives 348 horse-power of boilers for the same chimney, while it gives no way of getting at the size of grate to be used in connection with a certain size chimney.

The results obtained by using the above tables agree fairly well with the latest American practice and with English practice as well.

RUSTLESS COATINGS FOR IRON AND STEEL.

This was the fourth paper by M. P. Wood, New York city, on this subject, and presented additional evidence of the economy of carefully protecting iron and steel from corrosion. Some rather startling instances are cited where the nature of the iron has been completely changed by the corrosive action of certain fluids; in some cases being made so soft as to be readily cut with a knife. Mr. Wood claims:

"It is an indispensable condition, in applying paint for the protection of metallic surfaces, that the surface must not only be first prepared by cleaning it to receive the paint, but the manner and time that the coating is applied are strong factors towards getting a favorable result. A poor paint properly applied to a properly prepared surface will in general give a better and more lasting result than a good paint improperly applied to an improperly prepared surface."

* * *

In taking down old piping it is usually cheaper to break the fittings than to take time to unscrew them, as they are generally badly battered.

* * *

NOTES FROM A ROVING CONTRIBUTOR.—6.

MORE ABRASION—ROLLERS AND BALLS—AN ORIGINAL DISCOVERY—HOW TO MAKE CHILLED SPHERES—A ROLLER BEARING VALVE—SAWING GRANITE FOR TOMBSTONES—EXPLOSIVE CAST IRON—FUTURE REWARD—USE FOR AN ARISTOCRACY—HYDRAULIC RAMS.

I find I am not done with "abrasion" yet, and clutches will have to wait another month in spite of the editor's orders to switch—not nearly done yet, if we count by the redundancy of the subject, it is a wide one, running all through the arts—from polishing a watch pivot to holystoning a deck. Besides, there is one branch not touched upon at all, that of "rolling abrasion."

We do not know much of the cutting or tearing abrasion, as with stones, sand and emery, and very nearly nothing at all of the other kind, hence I am safe in treating upon it, and can, no doubt, interest the Professor who has a fondness for "pure science;" that is, things that do not admit of proof and present no pitfalls for an unwary writer.

I once mentioned the subject of roller and ball-bearings, and he at once found co-efficients for rolling and sliding friction, but when I asked about material, behaviour under pressure, etc., he said it was "lecture time."

Rolling abrasion was discovered as a practical fact by Gen. B. C. and Richard A. Tilghman, of Philadelphia, how and from what inference I do not know, but can guess at it, which will do just as well for present purposes. They were the inventors or discoverers of the sand-blast. I do not know which to call that, an invention or discovery. It required about twenty years for its

evolution, consequently was not a rapid "discovery," if that is the proper name.

My opinion is that the abrasion, produced by direct impingement of the particles in the sand-blast processes, where no sliding took place, led to investigation of rolling or "direct" abrasion. Anyone curious about this matter can make their own inquiries.

The discovery was, in substance, this: when material is too hard to be cut or abraded by rubbing, it can be reduced to smithereens by rolling spheres of other hard material under some degree of pressure not known, by me, at least. Inference would never lead up to such a heretical opinion as this, but the fact is easy of proof. Take a little sphere of chilled cast iron, or of any hard material that will not crush, put a metal bar on top and roll the sphere across a piece of glass. The result is a white line of pulverized material in the track of the sphere, and this repeated by thousands of spheres is "rolling abrasion."

The fact is that balls, rollers and other devices of "hair line" contact are, beyond a certain pressure, the most efficient agents for abrading hard material known to the mechanic arts, and, strange to say, under moderate pressure they will go on and wear for years. Grindstone shaft bearings and velocipede spindles furnish coarse and fine examples of this; but bear on a little harder, and the ball or roller bearing becomes a pulverizing device of the first order.

I am going to illustrate this by some facts. During the Civil War, thirty years ago, marine engines, especially in the navy, were quite a different affair from what they are now. Piston valves were not thought of, that is, nobody could make one that would give assurance of lasting a month; so the engines on some of the gunboats were fitted up with slide valves as large as a garden gate--unbalanced, and there was a kind of problem between the pull on the piston and the pull on the valve, which, for a like range of movement, was about equal, but the longer stroke of the piston left a surplus of power to be applied to the crank shaft.

To evade this friction of the valves there was an experiment made with rollers, a row on each side of the valve, hardened surfaces and all that, which were promptly disintegrated by rolling abrasion, as soon as started, and were taken out.

Some one recently fitted up a small rolling mill with roller bearings. I am waiting to hear from it, and will wager a year's subscription to this paper (to be begged from the Editor), that this rolling mill has been refitted by this time.

Another fact relates to sawing granite. I have been informed that down to the time of the chilled shot, or iron sand now in use in that process, granite could not be sawn "commercially," that is, for building and like purposes—unless for millionaires, and that granite sawing was confined to tombstones for people highly esteemed during life, who left opulent friends behind; but be this as it may, granite is now successfully sawn by the aid of rolling abrasion, produced by little pellets of chilled cast iron made and sold by the ton and mixed in with the sand that is fed to the saws.

There is plenty of data relating to this, but not at hand. As remembered now, the gain by the rolling process is as two to one or more than this.

There are not many readers of this paper who, if they had an order for a ton or more of chilled globules of cast iron, from a twentieth to five hundredths of an inch in diameter, would know just how to make them: at least, could do so for eight to twelve cents a pound; but it can be done. It was not done, however, at once by the inventors, there was the usual evolution to be gone over, ten to fifteen years, perhaps longer.

It was a most tedious matter, and cost enough to discourage anyone without a fortune of money and a large stock of perseverance.

In the first place the iron must be melted, and at 22,000 degrees and when granulated, will burn up as quickly as gunpowder. Anyone who doubts this can try it on cold iron, by setting a lamp under the point of a lathe-tool cutting cast iron, so that the fine dust will fall in the flame. This experiment will not cost two cents, and in connection with this learned essay is worth a good deal more than this. It will also relieve the writer of embarrassment.

Now, how to divide hot cast iron up into a fine sand, and not burn it up at the same time, was quite enough for fifteen years. It had to be reduced to globules or spheres at the same time and chilled, also. This last was not a difficult matter, because, as every one—at least, all who have tried to cut it—knows that charcoal iron, when suddenly cooled, is thoroughly chilled. All fins and thin sections are as hard as flint.

The other two features of attaining a spherical form and not burning up the particles, were not so easy. At first the melted iron was thrown out in finely divided spray by centrifugal apparatus in the chamber from which the oxygen had been pumped out, so the iron could not burn up. That cost a small fortune and would not do. Experiment after experiment followep until about the time the patents expired the manufacture was

It is a case where a new art and manufacture was created—absolutely new. There was not an idea or a scrap to build upon, nor is it the only thing these indefatigable investigators have dug up out of chaos. Not improvements. They do not deal in second-successfully established, and if the inventors live long enough they may get back the money they have expended. Their reward for services will come in the future world, if at all.
hand ideas, and just here comes in a thought for the Editor to cut out as non-technical.

We rail at an aristocracy fairly, no doubt, but there is something to be said of the other side. There is usually something to be said of both sides of any subject, and for modern aristocracy there is the fact that many of them with intellect, leisure and money, have contributed a good deal to useful investigation. The breeding of domestic animals by the English noblemen is one case.

Count Rumford, as a Connecticut school-master, and a Tory one at that, would never have discovered the co-relation of heat and work. He did a good deal more, too, than drive a drill in an old cannon with a horse whim, and gauge the heat generated, he modified the social condition of the poor in the Duchy of Baden; eliminated the tramps and beggars; brought cosmos out of chaos, so to speak, because he had leisure and position as a Count, with no care of dividing $30 a month up into raiment, food and the other necessaries of life, as he did in the Connecticut school.

I am trying to convince the Editor that if he would honor my draughts with double the amount written in, it would much improve these articles, but his views thus far, are that I am having a "good time" ferreting around works and factories, and should, like the members of the Pickwick Club, proceed at my own expense.

Money and leisure, which are much the same thing, do not always lead up to investigation. They oftener breed hobbies, generally useless and sometimes ridiculous. I know a rich machine maker who spends his extra time and money in gathering up ancient worm-eaten cabinet ware An old ramshackle desk, made of bog oak in the twelfth century, is to him a thing of rare beauty and merit, because it is old and useless. Another rich machine maker I know has a wonderful collection of old books; another, of pictures. It is their own matter, of course, but something else would be more consistent.

Brownlee Brothers, Scotchmen by trade, of Port Dundas, which means a suburb of Glasgow, in Scotland, had a saw-mill and joiner works out there. Mr. James Brownlee, one of the brothers, having leisure and means, concluded he would find out how much steam would pass through a hole. This was his "hobby." He partitioned off a room in the saw-mill, lined it with sheet metal all soldered, air tight; blew into the room through various kinds of nozzles, steam at certain pressures and for definite periods, and then weighed the water condensed from the steam.

This took a long time. Hundreds, perhaps thousands, of tests were made and the result was "James Brownlee's tables" for the flow of steam, much prized at the time by engineers and yet a standard reference, no doubt.

Such a hobby has interest, use and a reputation in it. This is a hint for rich mechanics, if such there be, who affect to admire pictures, curios, fast horses and the like. There are numerous dark places in the mechanical field, "crannies and dog holes" as Carlyle calls them, that need a light thrust therein. Let me point out one—hydraulic impulse machines, called "rams" in our perverse machine nomenclature.

What do we know about these? how they act? how to make them and what they should cost, and when to use them? I will ask the Editor to send a chromo to any reader who will answer any one of these questions in a way to command confidence, especially the last question.

Mr. Ross E. Browne, a mining and hydraulic engineer, of justly earned eminence, some years ago worked out a much harder problem which he called "The economic head for long pipes." It was a move in the same direction as to ascertain what are the economic circumstances that permit the use of hydraulic rams.

I will add a new hat to the Editor's chromo for anyone who will send a solution of this problem. The limitation is one of cost compared to water wheels and pumps, taking into account efficiency, maintenance and investment. There are not in the whole world ten machines of the kind with pipes exceeding twelve inches diameter. Why?

One with a twelve-inch driving pipe was made about thirty-five years ago by Mr. Washington Jones, at Philadelphia, for a firm in Cuba. It was carefully made, and no doubt did good service, but I can find no record whatever. Mr. Jones, just before this was written, admitted that he knew no rules of construction for such machines and had proceeded empirically, with "fear and trembling."

Mr. Pearsall, an English engineer, about six years ago made some "hydraulic engines," as he called them, of the ram persuasion, that is, they operated by momentum or impulse the same as a ram, but the valves closed gradually. He made machines with supply pipes as large as twenty-four inches bore, and attained a working efficiency of seventy per cent.

Another departure is that of M. Le Michel, of Paris, who, a little later, brought out his curious modification of the ram tribe in which the discharge pipe was the motive power, acting by air pressure or as a siphon. The apparatus was set at the top, or at any point above, instead of the bottom of the head, and the pulsations were produced by a resillient diaphragm—a kind of drum head that kept vibrating while the discharge down the discharge pipe was constant. These machines would draw from a well and could be set anywhere, so long as the discharge was lower than the supply level.

These two departures are about all since the first rams made by Montgolfier, 110 years ago.

All this is written here to induce some millionaire to engage in ram investigation, and is all lost unless he does. Think of the honor! The patron would get the credit. His name would be indelibly written on the scroll of science: "Jones' experiments on hydraulic rams, or hydraulic impulse engines." The professor could make up the quantities, I would work the rams and the Editor would work the review notice. Think, too, of a tombstone with this inscription:—

Hic jacet—John Jones, by whose munificence and interest in physical science, was developed the law of hydraulic rams. A public benefactor, to whom this monument is raised.

De mortibus nil nisi bonum.

* * *

DON'T try to fix a pulley which has become loose on the line shaft, till the shaft has been stopped. It looks easy to just slack the set screw a little more, to prevent scoring the shaft, but a slight turn in the wrong direction may jerk the wrench out of your hand and send you flying in a parabolic curve, towards the floor, even if it doesn't wind you up in the pulley. Let the shaft score; don't touch the pulley till the shaft stops.

* * *

DESIGNING AN ENGINE SHAFT GOVERNOR.—2.

THEO. F. SCHEFFLER, JR.

Referring to drawings, Fig. 1 illustrates a side view of governor wheel, and parts all assembled, showing the general arrangement. Fig. 2 is a vertical section view on line AB. The general details of the governor are illustrated on four separate sheets; Figs 3 and 4 show detail of governor weight, and Fig. 5 is the weight cheek piece; Figs. 6, 7 and 8 show details of eccentric; Figs. 9, 10 and 11 illustrate the eccentric case, which is arranged for taking up the wear; Fig. 12 shows the dash-pot and details of same. The eccentric is made of cast-iron as usual; the eccentric case is also made of cast-iron; the weight arm is made of cast-iron, and provision is made for filling weight with shot or lead, in order to obtain a heavier weight should it be required. All of the pins and spring-adjusting screws are made of the best machinery steel; the connecting links between the eccentric and weights are usually made of wrought iron, but can be made of malleable iron, and cored out for oil as the drawing illustrates; the spring-nut is made of cast-iron, and the dash-pot is made of brass. All parts in designing the governor should be made as light as possible, consistent with sufficient strength of material. Every wearing part of any description should be provided with an oil or grease cup, which will thoroughly lubricate the wearing surface in the best possible manner. To calculate the size of spring for the governor, first determine the amount of pull at governor weight necessary to handle the valve with ease, then calculate the pull at spring in ratio with pull at weight, that is, find the equivalent amount of pull obtained by the leverage of the weight arm; then determine upon the proper size of steel to use in spring, and also the distance from center to center of steel; if the material is round, and the number of coils required, allowing a good factor of safety between each coil. The size of steel can be calculated from the following formula:

Let P = greatest safe load in pounds.
" R = radius of spring in inches from center of coil to center of steel.
" D = diameter of steel in inches.

Therefore $P = \dfrac{11480 \times D^3}{R}$

The opening of one coil per 100 lbs. can be determined from the following formula:

Notation as in above formula.

Let F = deflection by a load of 100 lbs. for each coil.

Therefore $F = \dfrac{R^3}{181250 \times D^4} \times 100$

In connection with calculating springs, and to save time in figuring them, a small table has been compiled, which may be used as a reference; the above formulas were used in making the calculations.

Governor Spring's. Table No. 1

A = Diameter of Steel in inches.

B = Outside diameter of coil. - C = Deflection by a load of 100 pounds per one coil. D = Safe working load in pounds.

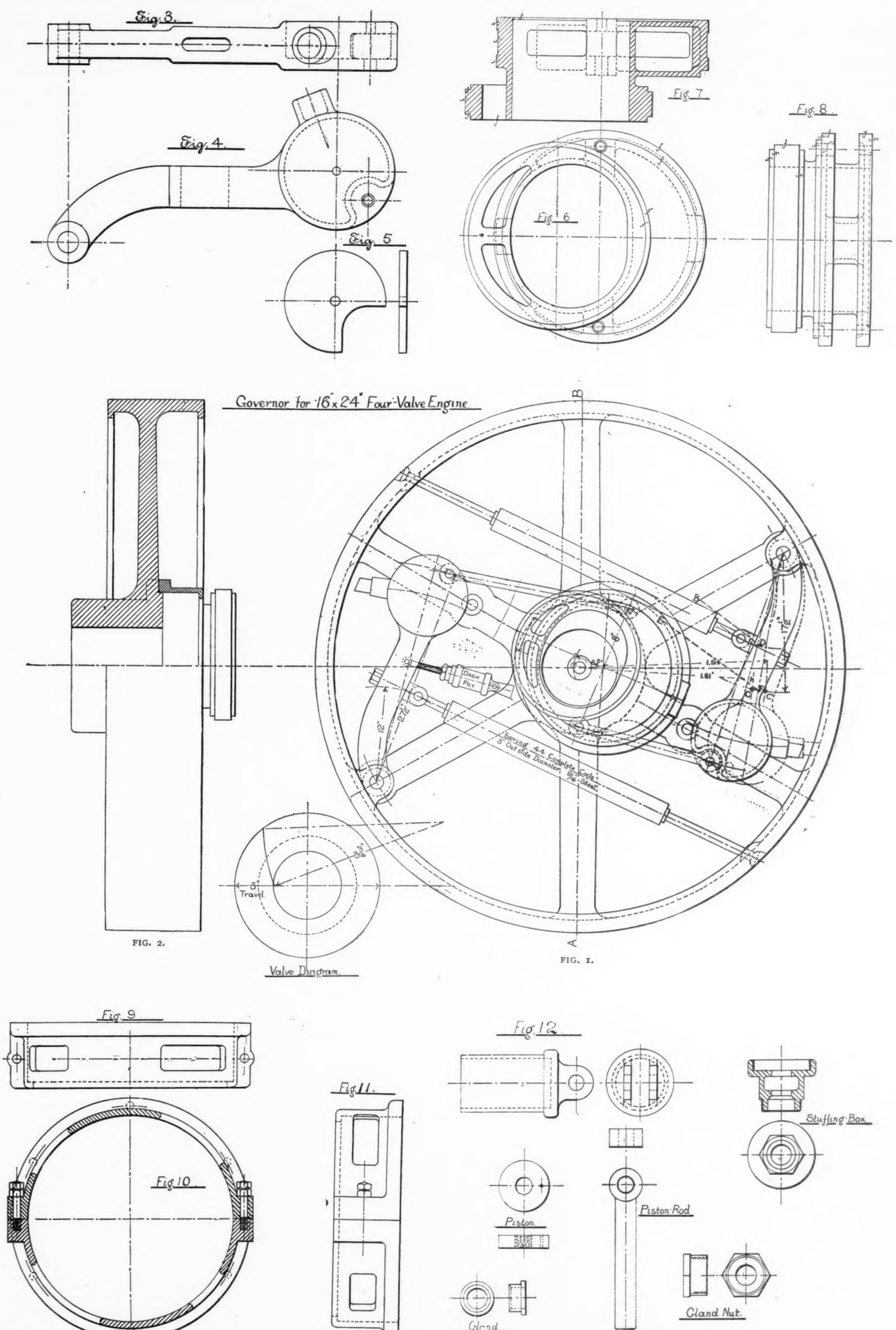
A	B	C	D	A	B	C	D	A	B	C	D
.065"	1/4"	.0243	34.1	7/16	2	.00717	1227	5/8	3 1/2	.0107	1950
.065"	1/2"	.3173	14.4	7/16	2 1/4	.0112	1057	5/8	3 3/4	.0137	1796
065"	3/4"	1.242	9.2	7/16	2 1/2	.0165	930	5/8	4	.0171	1661
.120"	1/2"	.0182	104	7/16	2 3/4	.0232	833	11/16	3	.0038	3219
120"	3/4"	.0833	63.9	7/16	3	.0316	748	11/16	3 1/4	.0051	2905
.120"	1"	.2271	45	7/16	3 1/4	.0418	684	11/16	3 1/2	.0068	2647
180"	3/4"	.0121	231	7/16	3 1/2	.0548	626	11/16	3 3/4	.0088	2431
.180	1"	.0389	163	1/2	2	.00372	1906	11/16	4	.0111	2247
180	1 1/4"	.0805	126	1/2	2 1/4	.00591	1640	11/16	4 1/4	.0138	2089
180	1 1/2"	.1513	101	1/2	2 1/2	.00882	1435	3/4	3	.0024	4304
1/4"	1 1/4"	.0177	358	1/2	2 3/4	.0125	1275	3/4	3 1/4	.0034	3874
1/4	1 1/2"	.0345	287	1/2	3	.0174	1148	3/4	3 1/2	.0045	3522
1/4	1 3/4	.0597	239	1/2	3 1/4	.0229	1043	3/4	3 3/4	.0058	3228
1/4	2	.0948	206	1/2	3 1/2	.0297	956	3/4	4	.0074	2918
5/16	1 1/2	.0121	590	9/16	2 1/2	.0050	2122	3/4	4 1/4	.0093	2767
5/16	1 3/4	.0226	478	9/16	2 3/4	.0072	1869	7/8	3 1/2	.0021	5861
5/16	2	0348	413	9/16	3	.0099	1684	7/8	3 3/4	.0027	5351
5/16	2 1/4	.0529	358	9/16	3 1/4	.0133	1520	7/8	4	.0035	4923
5/16	2 1/2	.0661	326	9/16	3 1/2	.0174	1395	7/8	4 1/4	.0044	4559
3/8	2	.0160	744	9/16	3 3/4	.0222	1281	7/8	4 1/2	.0056	4244
3/8	2 1/4	.0246	645	9/16	4	.0275	1191	1	3 1/2	.0010	9184
3/8	2 1/2	.0359	570	5/8	2 1/2	.0029	2991	1	3 3/4	.0014	8349
3/8	2 3/4	.0501	512	5/8	2 3/4	.0043	2643	1	4	.0018	7653
3/8	3	.0677	462	5/8	3	.0060	2361	1	4 1/4	.0023	7064
3/8	3 1/4	.0889	423	5/8	3 1/4	.0081	2163	1	4 1/2	.0028	6560

* * *

THERE is a frankness and sincerity about the editorial of *Engineering*, of London, in regard to the American tools which were exhibited at the Stanley Cycle Show, that is refreshing, as it shows how men can rise above the alleged patriotism which demands praise for everything "we" do and condemnation for the doings of others. We do not think this commendable quality is wholly English, but we regret to say that we see more of it in the technical papers of that country than in our own. It is a far truer patriotism which shows why others have excelled and points out our own weak spots, than that which attempts to gloss over our faults, or stubbornly proclaims that none exist.

* * *

WE are again indebted to the Jos. Dixon Crucible Co., Jersey City, N. J., for a box of assorted pencils, as is their custom at the holidays. They need no recommendation, as their good qualities are well known. We shall endeavor not to let our anxiety to try the blue pencils make us slaughter contributions unnecessarily.



DESIGNING AN ENGINE SHAFT GOVERNOR.—SEE PAGE 186.

DEFECTIVE STEAM HEATING PLANTS.

W. H. Wakeman.

There are a variety of defects which will cause a steam plant used for heating purposes, to work in an unsatisfactory manner, or prevent its working at all, some of which I wish to call attention to in order that, if they exist in places where readers are located, remedies may be applied. In one case that came to my notice, the exhaust steam from an engine was allowed to go to waste, while another boiler was fired up as soon as cold weather came on, and was run all winter under a low pressure for heating purposes. Some changes in piping, the object of which was to conduct the exhaust steam to the heating coils and costing about $25, resulted in the saving of about $150 in one winter, although the plant is but a small one.

In another case, where the buildings were heated partly by live steam and the remainder by exhaust, the water of condensation from the exhaust was allowed to go to the sewer, although the hot water from the live steam pipes was returned to the boilers. A recommendation that the drip from the exhaust be also returned was met by the statement that it could not be done because there was cylinder oil in this water. Quite true, but why not take it out and save the pure water? A separator costing about $100 would effectually remove it and allow the use of this water, and as the exhaust steam was used for heating certain rooms all the year around, the investment would be a paying one, for the feed water was bought by meter measurement and the bill was more than $200 per year.

The practice of trying to regulate the supply of steam from the boiler to the heating system by means of a valve operated by hand, is a bad one, provided it is desired to keep the pipes full of steam, for sometimes there will be too much pressure in the pipes, and at other times not enough to fill the whole of them; consequently the system becomes noisy. A good reducing valve should be put in where it can control the supply, so that when varying quantities of steam are called for the supply and demand will be equal quantities.

While talking on this subject with a steam user, he expressed the idea that reducing valves were of no value, as they never worked when wanted. In this opinion he was supported by his engineer, a man grown gray in the service. This suggested the idea that while some engineers always have good success with automatic appliances, others pronounce all of them failures. What makes the difference?

Here are fifty automatic appliances, all made in the same shop, and by the same men. When they are put into service, twenty-five of them are pronounced satisfactory and the remainder are condemned as failures. Why is this so, and where shall we look for the trouble? Out of the twenty-five that are unsatisfactory some are failures owing to the conditions under which they were used, and the rest are ruined by men who know and apparently care nothing about them.

Another cause for pounding and thumping in the pipes, is the fact that they are not put up so as to allow the water of condensation to run to the lowest point, which should be the receiver, from whence it should be taken by the pump and returned to the boilers; but that at several points in its journey it must run up hill.

In a certain heating plant a portion of the coils and radiators were drained into a trap, the outlet of which was automatically controlled by a float which opened a valve when water collected in it, and as the water level was lowered the float would fall and close the valve. A happy thought came to the engineer in charge one day, and he resolved to save the hot water discharged by the trap; so he ran a pipe from the trap to the receiver in order to do it. Now, the idea was a good one—worthy of imitation, but the way in which the attempt was made to carry it out made it a failure, because the engineer did not understand the elements of natural philosophy. It would be plain to anyone who is competent in this line, that the pipe from the trap must be inclined downward to the receiver, but on the way it was necessary to either go under or over the passage-way; so the pipe was carried up vertically about four feet, and then continued on its downward course. The consequence was a continual thumping in the pipes, for water would collect in the trap and also in the main drip pipe back of the trap, until a point was reached that equalled the height of the highest part of the drip in front of the trap, hence the trap was of no value whatever, and might have been taken out altogether without detriment to the system. When the operatives in the factory had ceased to be amused by the noise of the water hammer, one of them would open the blow-off valve in the bottom of the trap and allow the water to escape out of doors. There is only one thing about the whole scheme that seemed strange to me, and that was the persistent claim of the engineer that his plan was right, even after the mistake was pointed out to him, and he could not make it work properly.

His claim was that three pounds pressure would force water up this vertical pipe, but he could not see that he did not have the three pounds to do it with, for as the pressure of steam in such a system is nearly equal at all points, or at least supposed to be, the calculations for the piping must be made as if there were no pressure whatever in the system, and gravity the only force relied on to bring water back to the receiver. Men who will not profit by their own mistakes, have but little chance to accumulate a valuable stock of information.

Another mistake that is sometimes made, although of a similar nature to the one just mentioned, is in locating the receiver with its pump. In order to get this down where it should be to work right, it may be necessary to dig a small pit and wall up the sides, so that an effort is made to economize and the receiver is put somewhere to look well, which is all proper and right, provided efficiency is not sacrificed thereby. In locating open heaters, it is recognized that the pump must be placed so that the hot water will flow to it, and it seems to be taken for granted that because there is pressure on the suction side of the pump the water will be forced up hill to it, but, as before stated, the pressure is equalized, therefore it is the same as if none existed.

Sometimes the condensation from a single coil or room will not return, but will stand in the pipe until blown out to the sewer. In a certain case where this trouble existed, I found that the feeder for this room was not large enough, the philosophy of the failure being that while the pipe would furnish some steam, it could not maintain boiler pressure, and as this was one of those systems where no reduction was admissible, the check valve was kept closed by the pressure from the other returns—therefore no water could pass through it.

If we shut off the steam from the system without shutting down the hot water pump, we shall have some music without delay; but if there is some water in the system, while cold, we can start up the pump and take it out without trouble. I have been asked the cause of the difference in action of the pump. If we shut steam off from the heating system and leave the pump running, when steam begins to condense it leaves a partial vacuum in the pipes, and as the pump can get no water under these conditions, although there may be enough in the receiver to hold up the float and so keep the throttle valve to the pump open, which will cause the pump to race. On the other hand, if the whole system is cold and we start up the pump and begin to take water out of the receiver, this will tend to also cause a partial vacuum in the pipes, but it should be remembered that as there is no heat in the system the air valves will be open, and thus allow the air to enter and take the place of the water removed, therefore there is nothing to disturb the smooth action of the pump.

* * *

HOW DIXON HIRED OUT AS SUPERINTENDENT.

A. P. Press.

Did you ever hire out as a superintendent? Well, never mind, lots of your readers have and lots more of them who are now "jours" will hire out as "supers" in the days to come, and both parties will be interested in what I have to tell.

Dixon is a friend of mine, and has just been through the mill, and he was telling me about it. I call him Dixon, because that isn't his name. Well, Dick heard that the Bay State Tool Works wanted a superintendent. Dick had been foreman down to the Marine Engine Co., for three or four years, and he knew the ropes pretty well; had run the shop six months once while the Old Man was on a visit home to the old country, and had done all the buying and contracting, as well as the hiring and firing, and so he went down to the Bay State Company to see what he could make out. He put on a clean collar and his best rig and went down early one Monday morning.

The shop was close to the depot, and Dick walked up to the office and asked for the manager. He was in and Dick stated his errand without delay. The Old Man invited him into his private office, gave him a chair and began to pump him. Where

did he learn his trade? Who had he worked for? How many men did he handle? and what wages did he get? Dick told him the truth, even to the wages question. Then the old man went on to tell him of the duties of a superintendent, how he must be ready to do anything, from buying a new engine to sweeping out the office, how many dollars worth of machinery and tools were under his control, and how on him depended the question of profit or loss to the company. Dick kept quiet and took it all in until he got through, and then asked him what shape the plant was in, how many men did they employ and how did the costs compare with the receipts. The Old Man told him pretty straight; they were in rather a bad fix. The old super had been there ten years, had done well the first eight years, but the last two years they had not made much money, in fact had got behindhand and he had got discouraged and had left and gone over to Newman & Youngs, a new shop that had just started in the same line of tools; said he was doing well and they were taking away what little trade they had left. The Old Man was a little bitter against him for going, but said he had left fair in every way; had said that if they would buy a new gear cutter, two or three turret head screw machines and scrap a lot of chain lathes and replace them with new ones, he would stay. The Old Man said he did not propose to do any such thing; said these lathes has cost them a good round sum, and he could show it on the books, and he guessed the old super was a little off.

They talked the thing over pretty well, and he then he took Dick over the plant. They did not have a very great outfit at the Marine Works, but it beat anything he could see at the Bay State plant, and he saw enough to make any superintendent feel discouraged, and he did not wonder the old super left—wondered he stayed as long as he did. There were old castings piled up everywhere, under the benches and in back of the stairs. The Old Man said he was not going to have them scrapped; said they would come in handy some day, said they cost him 3½ cents a pound and would not bring over ⅝ cent now for scrap.

Well, Dick looked over the plant to his heart's content, and they went back to the office and began to talk salary. Dick was getting $30.00 a week at the Engine Works, and had a sure thing of it, but wanted to make a change. The Old Man made a bid by offering $1 400.00 a year. Now that was less than the $30.00 a week Dick was getting, and he would not listen to it, and set his price at $1 700.00. The Old Man was indignant; said he only paid his old superintendent $1 800.00, although he did hear he got $2 000.00 over to Youngs, and all he could think of paying a new man was $1 600.00 at most, and he wanted to see some results right away.

They talked over the question an hour or more, or at least the Old Man did, for he did most of the talking. Dick did not say much of anything until it was nearly time for him to take his train, and then he said he had better be going. The Old Man said that he was going to the depot and he would go along also. They walked down the street, the Old Man trying to make Dick come down to the $1 600.00 mark They got to the depot and Dick got his ticket and got aboard the train, and the Old Man came along to the window on the side of the car and said: "Well, Mr. Dixon, I guess you had better come down and start in the first of the month at your own price." "All right," said Dick, and the train started. He has established a precedent, or at least he hopes he has, that he will not give in when he is sure he is right, and he is going down next month to take hold. I will hear from him once in a while, and I will let you know how he makes out.

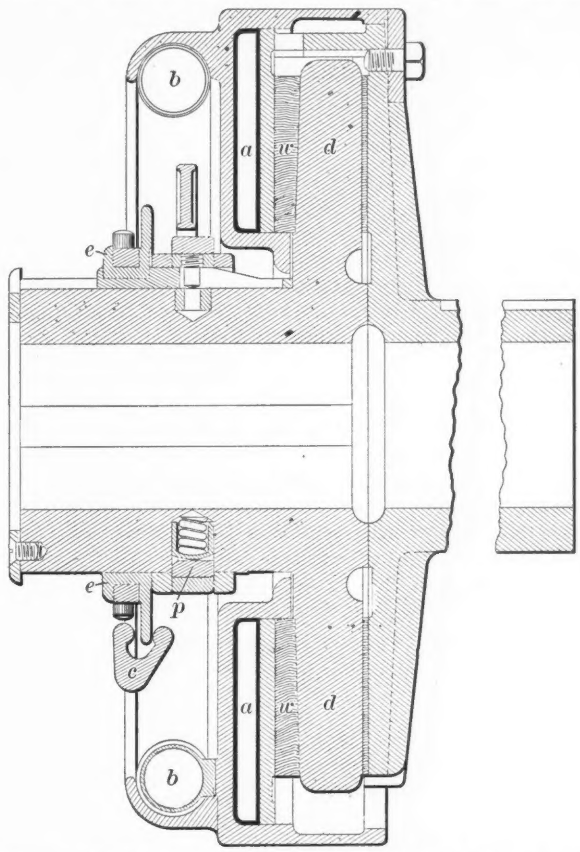
* * *

MESSRS. CHAS. CHURCHILL & CO., LTD., the well-known English agents of American machinery, send us a brief description of their new stores, 9 to 15 Leonard St., London, E.C. These are within ten minutes' walk of the Bank of England, the commercial center of London, and also next door to the City and Guilds of London Institute, one of the largest technical training colleges, making it a particularly good place for the students—the engineers of the future—to become familiar with the tools displayed.

The total floor space is 12 474 feet, divided among four floors and a basement, and having all the modern conveniences, including telephone service with all England over the lines of the National Telephone Company. They report the outlook very encouraging, and hope to increase their business over 1896, which was a particularly good year.

A NEW FRICTION CLUTCH.

The Automatic Friction Clutch Co., of Erie, Pa., are making a clutch which has several novel features, a section view being shown in the accompanying cut. It consists essentially of two parts, a disk *d* filled with hardwood blocks and a shell containing



a pressure chamber *a* and two polished iron friction surfaces, between which the disk *d* revolves. The hub of the shell carries the pulley to be driven.

The shell carries a reservoir containing a liquid, and a pump *p*, by which the liquid is forced into the pressure chamber *a*, forcing the friction plate against the blocks, gripping them between the surfaces shown. Throwing the shifting sleeve, as in any clutch, the pump goes into action, the release valve is closed by finger *c*, and the pressure increases until the clutch and pulley are revolving at the same speed, when the pump goes out of action automatically; being driven, in fact, by the *relative* motion between shaft and pulley. Moving the sleeve out, the finge *c* opens release valve and the liquid returns to the reservoir, the clutch stops and is ready to do it over again as soon as may be needed. Most of the wear will, of course, be on the wooden blocks, it being automatically taken up by the pressure plate The clutch is made quick-acting at low speed, and slow-acting at high speed if desired. The half-tone, Fig. 2, gives a good idea of the general appearance of the clutch.

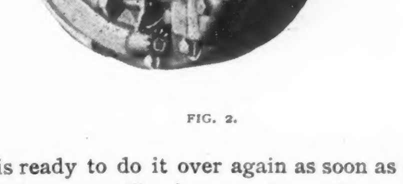


FIG. 2.

* * *

THE new man in the shop is subjected to much criticism and scrutiny, but he very often has several handy kinks up his sleeve which raise him in the eyes of the older men. This makes it rather risky to indulge in any sarcasm as to his way of working till you know how much work he can do in a day; he may paralyze the old method when it comes to time.

VALVE GEARS.—4.

E. T. ADAMS.

We saw in a former paper that this length was fixed by the frame, cylinder, etc., and that it was not affected by the throw or the position of the eccentric, or by the form of the valve, and, in fact, with the eccentric in its new position in relation to the crank, if we turn the shaft backward until the center of the eccentric falls at *c*, which is its mid-position, the valve will be moved back until

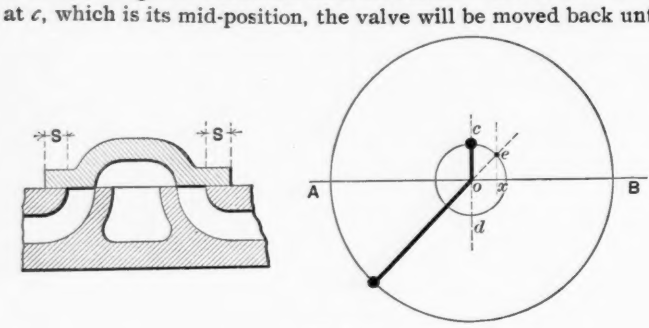


FIG. 21.

it just covers the ports, as in Fig 18, which is evidently its mid-position. This proves that the present length of eccentric rod is correct. There seems then but one thing to do, and that is to build out the outer edge of the valve at *s*, Fig. 20, until it barely covers the port. A little reflection and a careful study of Figs. 18, 19 and 20, will bring out three facts:

1st. The amount thus added to the valve will approximately equal *o x* or the projection of the arc *c e* on AB, which is the distance by which the center of the eccentric was advanced.

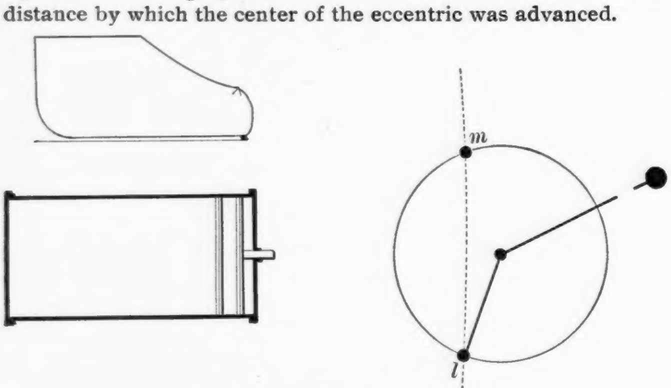


FIG. 22.

2d. When the valve is in its mid-position the edge of the valve will lap by the edge of the port at *s* by exactly the amount thus added.

3d. The fact which is, perhaps, not quite so obvious, that when the crank is at B the eccentric will be at *f'*, and it will be necessary to add the same amount to the steam edge of the valve on the other side. Fig. 21 shows the valve with these portions $s=ox$ added. The width of the strip of metal, *s*, thus added—or what

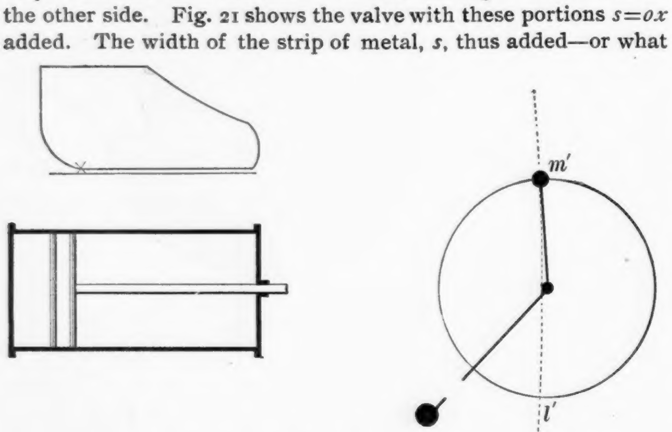


FIG. 23.

is the same thing, the distance by which, when in its mid-position, the valve laps by the edge of the port, is called *lap* or *steam lap*, to indicate that it belongs to the steam edge of the valve. The angle *c o e* through which we turned the eccentric is called the *angular advance*; it is measured from the line *c d*, which is perpendicular to a line joining the crank dead-points, A and B.

We may sum up, then, by saying that we have secured an earlier cut-off by adding steam lap to the valve and by giving the eccentric a certain angular advance.

We now have the eccentric and valve correctly located as regards the piston and crank, the only possible change that can now be made in order to bring the points of release and compression at the desired places in the stroke, is a change affecting the form of the exhaust edge of the valve. Now, in drawing the theoretical card, we assumed that release should take place at $\frac{95}{100}$ stroke, while compression was to begin when the piston was at $\frac{5}{8}$ stroke, or possibly at a point somewhat earlier than this.

Fig. 22 accordingly locates the center of the eccentric at *l* for release, and as the valve must be in the same position again at compression; this must begin when the center of the eccentric reaches *m*. Now, we see from Fig. 23 that we have assumed compression to begin at $\frac{5}{8}$ stroke, as shown, which brings the

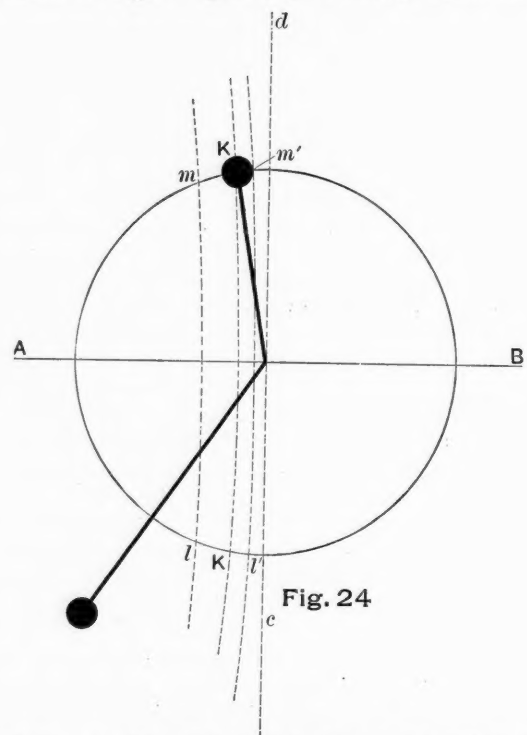


Fig. 24

eccentric at *m'*; evidently these points are not identical, and laying one drawing above another as in Fig. 24, we find that we can not have release when the eccentric is at *l* and also have compression when the eccentric reaches *m'*, this is evidently the trouble which it was surmised we should find in store for us.

Some compromise must now be decided on, and taking into account the considerations mentioned in the beginning of this paper, the writer decided that release and compression should occur when the center of the eccentric fell on the arc KK, Fig. 24, which makes release occur at about $\frac{9}{10}$ stroke, and compression when the piston reaches $\frac{4}{5}$ stroke. What change does this involve in the exhaust edge of the valve? Before the eccentric was

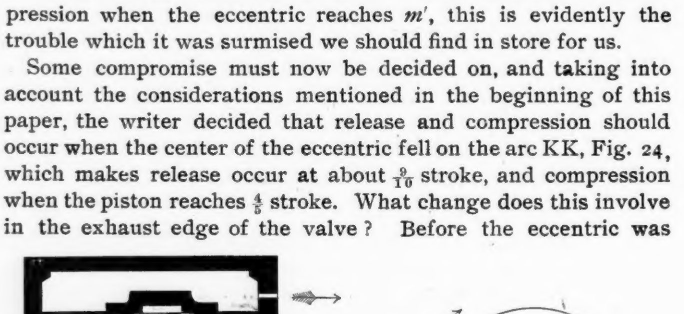


FIG. 25.

advanced on the shaft, release came just at the end of the stroke and there was no compression. The exhaust edges of the valve being just line and line with the port when the valve was in its mid-position, evidently the exhaust edge has been moved exactly the same distance as the edge of the steam valve, and to bring release just at the end of the stroke, we must add the same amount to the exhaust edge of the valve as was found necessary for the steam edge; this added width is called *exhaust lap*, and, as in the case of steam lap, is measured by the amount that the exhaust edge of the valve laps by the port when the valve is in mid-position.

In this case we have assumed that release is to occur *before* the end of the stroke, and the exhaust lap required is less than

would be necessary if release were to occur just at the end of the stroke. We may state this in another way, by saying that when release occurs just at the end of the stroke, the steam lap and the exhaust lap will be equal (neglecting lead), and as release occurs earlier the exhaust lap will grow less, and there may be, in fact, there often is such a thing as *negative lap*, that is—when the valve stands in its mid-position the exhaust edges of the valve may fail to cover the ports, the deficiency at either end is still exhaust lap but *negative* in this case. The valve shown in Fig. 17 has neither steam nor exhaust lap; that shown in Fig. 21 has steam lap, but no exhaust lap.

Evidently the exhaust lap in the present case is equal to the distance *k d*, just as we found the steam lap equal to *o x*.

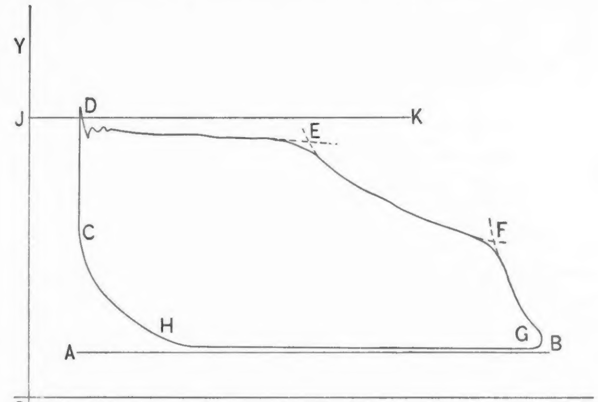


Fig. 1.

Fig. 25, then, gives the completed valve with the proper relative position of valve, piston crank and eccentric, and Figs. 26 and 27 give the actual and theoretical cards obtained under these conditions.

This has been a very laborious way of designing a valve, and in fact no one designs valves in this way. In practice valves are designed by a short and somewhat mechanical process, which will now be taken up. However, every expert designer, no matter what process of design he uses, carries along, perhaps unconsciously, as he works an analysis somewhat similar to that which we have gone through; and every stationary engineer, or erecting man, who would rise superior to his "rules for valve setting," and every designer who would be independent of his cut-and-

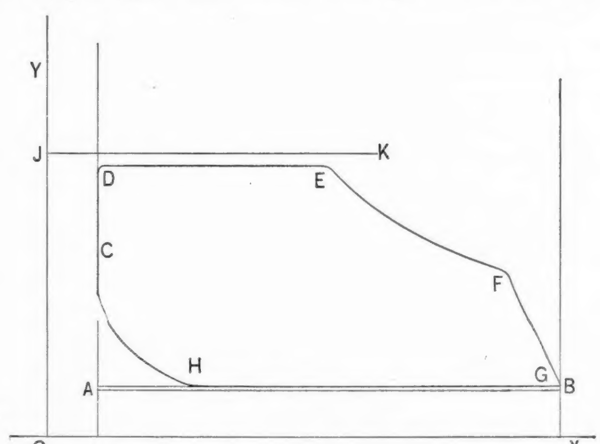


Fig. 2.

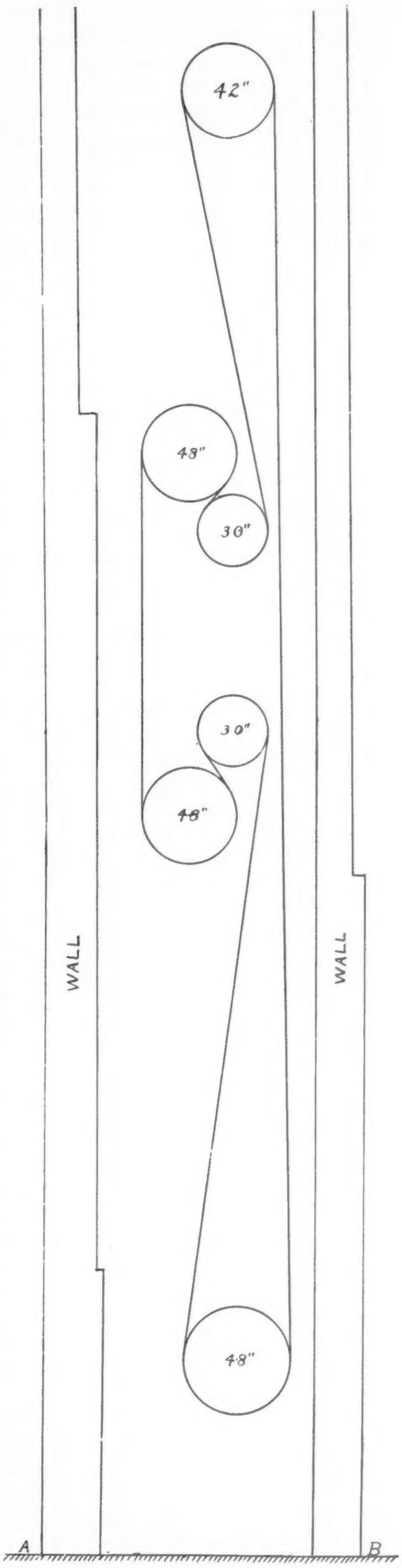
dried formula or rules for the proportions of a valve, must find his superiority and independence in a careful analysis of the action of a valve carried out somewhat on the lines indicated. To the mechanic in whom the ability to learn rapidly through the *sense of touch*, has, by long training, become acutely developed, there is nothing that can take the place of a model —it may be of wood or pasteboard, but something that can be handled and turned will be an invaluable aid, and will do far more than the writer has been able to accomplish in bringing out the simple *why* of each step in the process of valve design and adjustment.

* * *

Mr. Edward P. Thompson's book on Roentgen Rays, which we noticed a few months ago, has received very favorable mention from Lord Kelvin, for its accuracy and convenient arrangement.

A VERTICAL BELT DRIVER.

The power plant of the Worcester Corset Co.'s new factory in Worcester, Mass., which was designed by Mr. Geo. I. Rockwood, also of Worcester, has a rather novel belt drive that has some interesting features. The engine is one of Mr. Rockwood's vertical "compact" engines, a compound with a ratio of 6 to 1. This drives the main shaft in the basement from which power is transmitted to the factory by the belt system shown herewith.



The greatest amount of power is consumed on the top floor, where several hundred girls are employed in the sewing room, the two floors below using but little power, and the first floor none at all.

After carefully studying the conditions, Mr. Rockwood decided on having a belt tower built which would be fireproof, so far as communicating fire from one floor to another was concerned, and at the same time give free access to the belt and tighteners. The total distance between top and bottom pulleys is 53 feet 5⅛ inches; the intermediate pulleys being located as shown. The tighteners enable the belt to be kept at the desired tension on all the pulleys, and the system is giving entire satisfaction. This is quite a departure from the usual vertical shaft and the system of belting from shaft to shaft on the different floors, and evidently has much to recommend it for cases of this kind.

* * *

Mr. F. W. Clough, Springfield, Mass., who makes a number of mechanical specialties, has favored us with one of his adjustable T squares. These have a very simple and positive adjustment for centering the blade at right angles to the head, which should give no trouble from wear and which affords a practically solid T square when so used. The head can also be swiveled and locked at any desired angle. While we have never placed much dependence on adjustable T squares, this is so simple and secure that all the objections seem to have vanished.

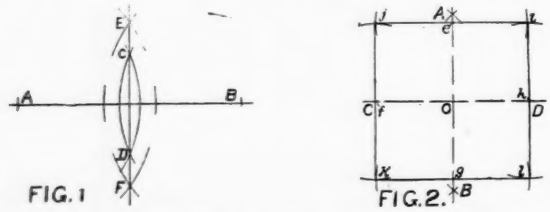
MY BACKWOODS PROFESSOR.—2.

JONATHAN JONES, JR.

SOMETHING ABOUT SQUARES, LINES AND ANGLES.

I was trying to lay out some work one day and couldn't find a tri-square or triangle with 90 degrees, and was about ready to give it up when Josiah asked me what the matter was. I told him.

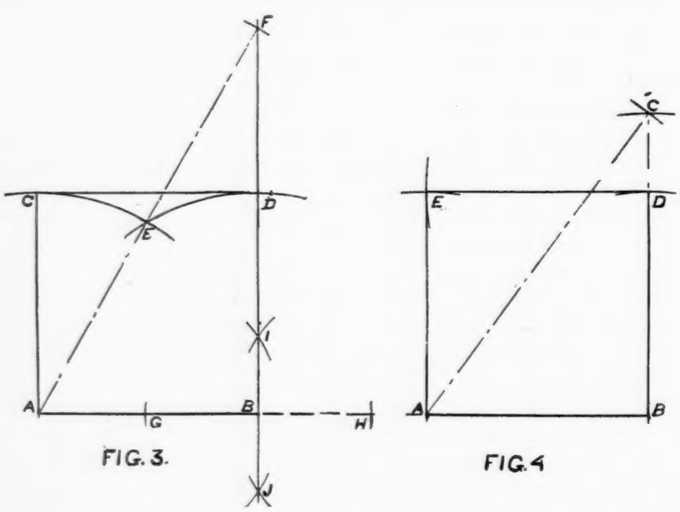
"Never mind, John; I've got one, but I won't let you take it until I show you how to lay out a square corner, any time you want to, whether you have a triangle or not. Work isn't rushing just now, and you may find it handy sometime. There are several ways of doin' it; I'll show you the easiest first. We only need my old dividers, a scale or rule, and a scriber to lay it out on this sheet of tin. Draw a straight line AB Fig. 1, (I put in the letters, he didn't), and take any two points—as A and B. Open the dividers to more than half the distance, don't matter how much more, and swing the arcs C and D from both A and B. Draw a line through their meeting points C and D, this line will be exactly 'square' or at right angles with the first one.



To show you that it don't matter what distance we take, so long as it is more than half, I'll draw others—E and F and you see that the same line passes through all the points.

Now, to apply this to your case. You want to make a square which is four inches on each side; draw a line CD, say 5 inches long, and measure off 4 inches as *f* and *h*. Take any radius more than half, say 3 inches, and draw arcs cutting each other as A and B, figure 2. Draw a line through A and B. Now take 2 inches in your dividers (or *h* O) and with one point at O mark points *e* and *g*. With same radius and point on *h*, draw arcs *i* and *l*; with point on *e*, draw *i* and *j*; with point on *f*, draw *j* and *k*, and with point on *g*, draw *l* and *k*. Where the arcs cut each other are the corners of the square, and lines drawn connecting these will form your 4 inch square.

Another way is to draw a line as A H, Fig. 3, take any two points as G and H, and erect a perpendicular as we have been doing, by the arcs I and J. Extend the line I J indefinitely.



Taking B as a corner, and with four inches between the dividing points, cut the lines at A and D. With point on D and A, draw arcs cutting at C; this gives C as the other corner of the 4 inch square.

Still another way is to draw AB, say 6 inches long, then, with point on B and 8 inches in dividers, draw an arc as at C; with point on A and 10 inches in dividers, draw another arc cutting the first at C, then CB will be at right angles to AB. This is an old method and is known as the "6, 8 and 10 rule," and means that a triangle having sides 6, 8 and 10 inches long, or in that proportion, as 3, 4 and 5 inches (or feet or anything else), 1½, 2 and 2½, etc., is a right-angled triangle. This discovery is credited to an old Greek philosopher, Phythagoras, who lived about 680 B.C., and it's a mighty handy thing to remember, too, see Fig. 4.

While we're talking about angles, I might as well tell you a little more on this subject, as I s'pose you want to know all you can. Of course you know an equilateral triangle has three angles of 60 degrees each, and that 30 degrees is, also, often used in laying out work—such as a center gauge. Going back to Fig. 3 and drawing the lines AH and JF as before, take the distance AB in the dividers, and with the point first on A, then B draw the arcs which cross in E. Draw a straight line through A and E (or B and E if you prefer), and with the same distance in the dividers and point on E, draw arc F. The triangle AFB is a 30 degree angle, and the side AF is evidently twice the distance AB, since we took the distance AB *twice* before reaching F. To draw an equilateral triangle we could proceed as before, and after drawing the arcs which cut at E, draw from A to E and E to B, when the sides will evidently be equal as well as angles. Just remember this, when you have to draw a 30 or 60 degree angle.

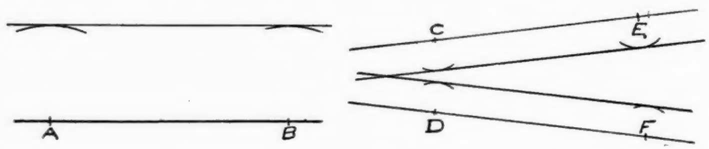


FIG. 5. FIG. 6.

You asked me the other day about drawing lines parallel. As I didn't have time then, I'll show you now. Draw any line as AB, from any points as AB, with the dividers set to the distance you want the lines apart, draw arcs like this, Fig. 5, then a straight line drawn tangent (touching), the arcs will be parallel to the first line."

Another good example of this is to draw two inclined lines, and draw lines parallel by the same method as shown in Fig. 6. I give this as an addition to Josiah's talk, so long ago, and have made the sketches from an old note-book I kept at that time. This note-book has helped me out of many a scrape, too, by the way, and I'm keeping one yet.

* * *

TESTS OF AN ALMY WATER TUBE BOILER.

TABLE NO. 1.

DATA AND RESULTS OF EVAPORATIVE TESTS ON ALMY WATER TUBE BOILER AT PROVIDENCE, R. I.

Grate Surface, 11.38 sq. ft.; Heating Surface, 474 sq. ft.

Kind of coal—George's Creek Cumberland.

Per cent. of moisture in coal	2.4	1.8	1.8	1.8
Conditions as to capacity	Normal.	Normal.	Forced Draft. 1-Heavy	2-Medium
Date of Test—1896	Oct. 31.	Nov. 2.	Nov. 2.	Nov. 2.
TOTAL QUANTITIES.				
1. Duration— hrs	9.15	6.1	2.03	2.0
2. Weight of dry coal consumed—lbs.	1 274.	971.	831.	543.
3. Weight of ashes and clinkers—lbs.	110.	100.	....	....
4. Per cent. of ashes and clinkers.—per cent	8.6	10.3	....	....
5. Weight of water evaporated	11 332.	8 610.	6 560.	....
HOURLY QUANTITIES				4 414.
6. Coal consumed per hour—lbs	139.2	159.2	409.4	
7. Coal consumed per hour, per sq. ft. of grate—lbs	12.2	13.99	35.98	271.5
8. Water evaporated per hour—lbs	1 238.5	1 403.6	3 231.	23.86
9. Equiv. evap. per hour, feed 100 deg., pressure 70 lbs.—lbs	1 300.4	1 472.8	3.389.3	2 207.
10. Horse power developed on basis of 30 lbs.—HP	43.3	49.1	112.98	2 315.1
11. Equiv. evap. per sq. ft. heating surface per hour—lbs	2.74	3.1	7.15	77.2 4.88
AVERAGES OF OBSERVATIONS.				
12. Average boiler pressure—lbs	147.1	146.8	153.6	140.1
13. Average temperature of feed water—deg	56.7	56.6	56.	56.
14. Average temperature of flue gases—deg	513.	473.	850.*	715.*
15. Average draught suction -inches	.12	.14	.71	.4
16. Per cent. of moisture in steam	0.35	0.4	0.72	0.42
17. Weather and outside temperature	Clear Warm	Clear Moderate	....	....
18. Total heat of combustion per lb. of dry coal—B. T. U	....	14 168.	....	....
19. Total Heat of combustion per lb. combustible—B. T. U	**	15 186.	....	....
RESULTS.				
20. Water evap. per lb. of coal—lbs	8.895	8.867	7.894	8.129
21. Equiv, evap. per lb. of coal from and at 212 deg.—lbs	10.736	10.694	....	....
22. Equiv. evap. per lb. of combustible from and at 212 deg.—lbs	11.746	11.922	....	....
23. Efficiency on combustible—per cent	....	75.8	....	....

* Only one observation. The actual temperature on the heavy forced draft test was higher than 850 deg, the limit of the thermometer used—probably 900 deg.

** See table No. 2 for heat of combustion computed from analysis.

The accompanying extracts are made from a test of an Almy water tube boiler, by Geo. H. Barrus, of Boston, which had been in use about fifteen months in their own shop.

The data and results of the tests are given in the tables, of which Table No. 1 relates to the general data and results, and Table No. 2 to the heat balance of October 31st.

TABLE NO. 2 (a).

RESULTS OF GAS ANALYSIS GIVEN IN PERCENTAGES BY VOLUME.

DATE, &c.	Oct. 31. Averages for whole test.	Nov. 2. One hour of main test.	No. 2, Forced Draft Tests.	
			1.	2.
Carbonic Acid CO_2	13.1	10.7	13.4	12.9
Carbonic Oxide CO	0.9	2.8	1.9	0.7
Oxygen, O_2	4.8	5.4	3.1	5.8
Nitrogen, N	81.2	81.1	81.6	81.5
	100.0	100.0	100.0	100.0

TABLE NO. 2 (b).

DATA FOR HEAT BALANCE.

Carbon in combustible—		87.	per cent.
Hydrogen in combustible—		4.7	" "
Carbonic Oxide in combustible—	$\frac{.9}{13.1 + .9} \times 87. =$	5.6	" "
Hot gas, not including moisture, per pound of carbon—		17.95	pounds.
Hot gas, not including moisture, per pound of combustible—		15.62	"
Temperature of gases above air—	513 — 72 =	441.	deg.
Heat in one pound of moisture in the gases—		1251.	B. T. U.

TABLE NO. 2 (c).

HEAT BALANCE.

	B. T. U.	Per cent.
Total heat of combustion calculated from analysis, per lb. of combustible. (Carbon 82.6%—Hydrogen 4.5%—Ash 5.1%—Oxygen 4.8%—Nitrogen and Sulphur 3%....	15 169	
1. Heat absorbed in useful evaporation—11.74 × 966 =	11 347	74.8
2. Heat lost in hot gas—15.62 × 441 × .238 = ...	1 639	10.8
3. Heat lost by sensible and latent heat of moisture in coal and moisture formed by burning hydrogen—(.047 × 9 + .024) × 1251 = ...	562	3.6
4. Heat of combustion lost by unconsumed CO, .056 × 10 050 = ...	503	3.2
5. Radiation as per test—........................	365	2.4
6. Loss from carbon in smoke, hydro-carbons in same, and unaccounted for—........................	753	5.2
	15 169	

It appears from these results that, in point of economy, the boiler compares favorably with the best types. An evaporation of 11.922 pounds of water per pound of combustible, which was obtained on the test of November 2d, is rarely exceeded by any form of hand-fired water tube boiler, whatever its size. One of the noticeable features in the operation of the boiler was the dryness of the steam exhibited on all the tests. Even with conditions of forced blast, when over seven pounds of water was evaporated per square foot of surface per hour, the moisture was less than one per cent.

The heat balance given in Table No. 2, shows that practically all of the heat units available in the coal, were accounted for, either in useful evaporation, or in chimney and other wastes.

* * *

ITEMS OF MECHANICAL INTEREST.

PERPETUAL MOTION AGAIN.

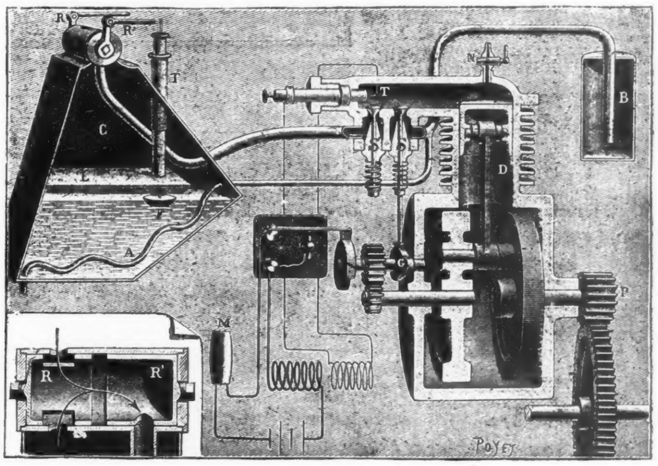
Another of the inventor tribe, this time from Maine, has sprung on the unsuspecting public, (backed by "several of the brightest engineers of the neighborhood") a perpetual motion machine, which not only motes itself, but stores power besides, in the shape of compressed air, to be used for anything you choose—from dusting carpets to supplying air for the cure of asthma in a sanitarium. Most perpetual motors are content to keep themselves running without revealing the real source of power. This one is ambitious, however, probably due to the invigorating air of Maine.

It is started, so the account reads, by simply turning the fly-wheel a few times, probably to limber up the "perpetuosity" for business, and then, away she goes, slowly at first but gaining speed and compressing air for other uses besides. Comment is hardly necessary, as we trust there isn't a reader of this paper so unfamiliar with natural or mechanical laws as to believe that "something can be had for nothing." It may work in financeering, for a time, but not in mechanics. The correspondent who kindly called our attention to it suggests that this and the Brambel engine be lumped together for the price we mentioned—$16.

THE DE DION-BOUTON PETROLEUM MOTOR.

The petroleum motor tricycle introduced nearly two years ago by Messrs. De Dion and Bouton, 12 Rue Ernest, Puteaux, France, is now a familiar object to those interested in the motor carriage movement. We give an illustration of the engine with its connections, together with a few particulars. It consists principally of two parts, the engine proper, and the carburetting reservoir. Dealing first with the latter, this is triangular in shape, arranged below the saddle, and is partially filled with petroleum spirit of 0.7 density. A vertical air tube, T, passes through the upper part of reservoir, and terminates in a horizontal metallic plate, L. The float F is provided to indicate the level of the spirit in the carburetter. Air enters by the tube T, and guided by the plate L, becomes saturated by petroleum spirit. It then rises to the upper portion of the container, where it comes in contact with two horizontal valves. One of these R, admits to the other R', in variable porportions, pure air, air saturated with petroleum spirit or a mixture of the two, the mixture passing from R' to the cylinder. The details of this valve are clearly shown in the section at the left-hand bottom corner of the illustration. The valves are regulated by two small rods and lever handles fixed on the frame of the machine within easy reach of the rider, so that the later may regulate both the composition of the explosive mixture and the quantity admitted to the cylinder.

The motor, which is of the vertical type, is enclosed in an oil-containing case of aluminium, and is bolted to the rear driving axle. A series of discs or radiators is cast round, and with the

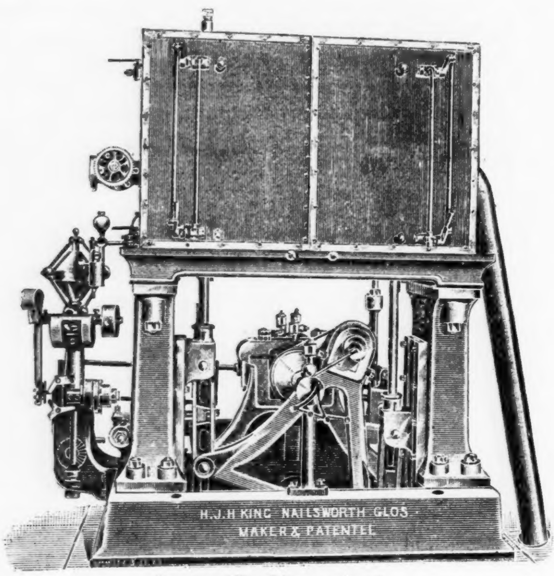


cylinder cover, serves to keep the cylinder cool, thus rendering any water cooling arrangement unnecessary. The distribution of the explosive mixture in the cylinder, which is of the single-acting type, is effected by means of the two valves S S'. The exhaust valve S is actuated by a cam G, on a small shaft driven by gear wheels from the main shaft. These gear wheels are so proportioned that the exhaust valve is only opened once every two revolutions. The noise of the exhaust is considerably reduced by causing the waste gases to pass into the box B, where they expand and pass quietly into the air through small holes at the top. In the illustration this cylinder or box is shown vertically, but it is fixed to the left-hand portion of the frame in a horizontal position. The evaporation of the spirit tends to cool it, and consequently reduces its volatilization. This difficulty is, however, overcome by running a serpent-like pipe A through the carburetter, through which part of the exhaust gases are ejected. The crank of the piston is connected, as shown, to two flywheels. The spindles of the latter project through the sides of the casing, the one on the right carrying at its outer end a pinion gearing with a larger wheel mounted on the axle of the rear wheels. The spindle on the left carries a pinion-gearing with another one on a secondary shaft, the latter carrying the cam actuating the exhaust-valve and also the cam which regulates the electric spark. The average speed of the tricycle is about 12½ miles per hour, equal to 1,400 revolutions of the engine shaft, or 700 explosions per minute. The reservoir will contain about four litres of spirit, sufficient for a run of nearly 60 miles.—*Industries and Iron.*

COMPOUND "KING" ENGINE.

Against the indisputable advantages of the long-stroke vertical type of mill engine, are the drawbacks of great height and cost, not only of the engine, but also of buildings and foundations, the latter requiring to be of extra depth in order to diminish vibra-

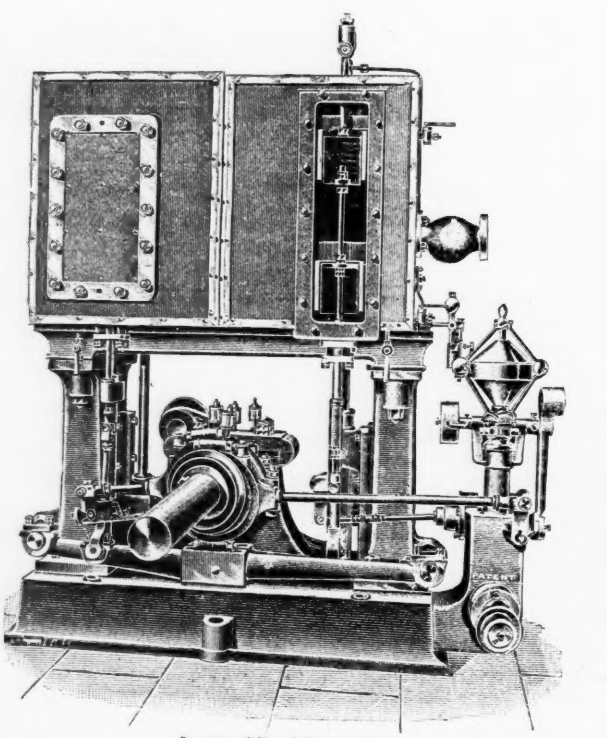
tion as far as possible, as well as the inaccessibility of the upper parts of the engine; and although this may be to some extent remedied by the provision of platforms, there can be no question that an engine which has every part within easy reach is much more likely to receive careful attention. Attempts have frequently been made to design an engine in which all the advan-



COMPOUND "KING" ENGINE.—FIG. 1.

tages pertaining to the marine type of vertical engine should be retained, without the attendant disadvantages referred to.

One of the most promising directions in which inventors with this object in view have worked, is in the adoption of a trussed or frame connecting rod, used in a somewhat peculiar manner to form the connecting link between two crossheads and one crank. By this arrangement a turning effort is obtained with one crank equal to that resulting from a pair of cranks at right angles, the engine having no dead centre. The steady running of engines of this type is demonstrated by the fact that they can be run in



COMPOUND "KING" ENGINE.—FIG. 2.

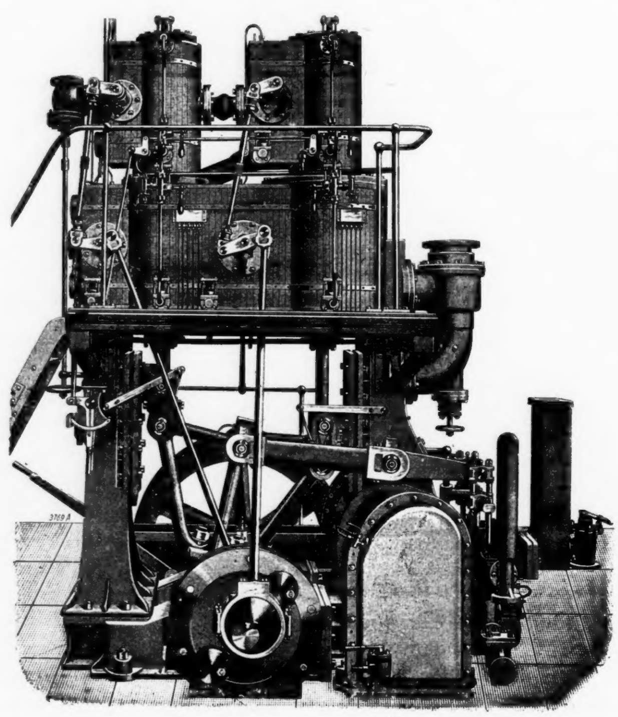
the shop at a full speed of 90 revolutions per minute without holding-down bolts, showing that expensive foundations are not required. As will be seen, the two cylinders are mounted upon a low framing carrying the slides for the two crossheads. These latter are coupled to the base of the triangular connecting rod by links as shown, and through these the power is transmitted to the crank-pin in the manner plainly indicated. It should be added that the lower side of the framed connecting rod is coupled at the center of its length to one end of a vibrating lever or radius rod, from the other extremity of which the air pump is driven.

The engine illustrated herewith has cylinders 8 and 14 inches in diameter respectively, the stroke being 27 inches. The boiler pressure is 100 lbs., and the engine runs at 70 revolutions per minute. The fly-wheel is 9 ft. in diameter, and is grooved for four 1½ inch ropes. In this case the jet condenser and air pump are placed below the ground; the air pump is double-acting, 7 inch in diameter and 11⅜ inch stroke.

A larger engine of this type has been installed at the mills of Messrs P. C. Evans and Son, cloth manufacturers, Brinscombe, near Stroud. This has cylinders 12½ and 21 inches in diameter respectively, the stroke being 30 in. The boiler pressure is 75 lb. per square inch, and the revolutions 75 per minute. This engine has a steel connecting rod of the triangular design, steel crossheads and radius rods, the brasses in all cases being made of phosphor bronze with wedge and screw adjustment. The links are made of forged steel, also fitted with adjustment brasses of phosphor bronze. The valve gear on the high pressure cylinder consists of a main slide valve with a gridiron expansion valve, actuated by King's patent trip gear, giving a sharp cut-off varying from zero to 75 per cent. of the stroke. The trip gear comprises two pawls which actuate a spring-held dashpot, the release of which is controlled by a wedge cam actuated directly by the governor. This, we understand, gives excellent results in economy, and ensures a uniform speed under a varying load. The low-pressure cylinder is fitted with an ordinary slide valve. This engine is at present loaded to about 80 I.H.P. Messrs. H. J. H. King & Co., Nailsworth, Gloucestershire, are the makers.—*Mechanical World.*

QUADRUPLE-EXPANSION MILL ENGINE.

We show from *Engineering* of London, another of this type of engine, recently constructed by Messrs. Fleming and Ferguson, Limited, Paisley, for the Clyde Components Manufacturing Company, of Birmingham. Though having four cylinders, the engine has only a single crank. The engine is of the vertical type, the cylinders being arranged in pairs tandem fashion. The high-pressure and second cylinders are placed respectively over the third and low-pressure cylinders. These cylinders are 9, 12, 16 and 25 inches in diameter, the stroke being 21½ inches.



The two crossheads, it will be seen, are connected by links to the top end of a steel triangular connecting-rod. The whole of the valves are of the Corliss type, those for the high-pressure and third cylinders being actuated by an eccentric, the cut-off being regulated by a sensitive shaft governor. This plan has been found superior to that of having the high-pressure valves alone under the governor's control, as the early cut-off in the third cylinder checks any tendency of the steam already in the engine to cause racing. A surface condenser has been fitted, being cast in one

with the back supporting column. The air, circulating, and feed pumps are driven from an extension of the radius lever of the triangular connecting-rod.

This engine was designed to meet special conditions, namely, that when the supply of water was short for condensing purposes, the engine could, at the shortest notice, be converted into a compound high-pressure engine of nearly the same power. This can be done by simply disconnecting the valves of the upper cylinders, leaving the two lower cylinders, 16 and 25 inches in diameter, to do the work as compound high-pressure engines, the condenser being shut off through a double valve placed on the exhaust pipe.

This valve opens to the atmosphere at the same time as it shuts to the condenser, and the change of engine from surface-condensing to compound can be done in a few minutes. This type of engine is claimed to be well suited for electric power stations on account of its simplicity, economy, steady running, and small floor space occupied. It can be made up to any size and power necessary.

* * *

Two PAPER MEN were talking about a certain scheme, and in the course of conversation one spoke of one of the parties in the transaction as a "promoter."

"Say, do you know what a 'promoter' is?"

"No; what is he?"

"Well, he is a fellow who is always trying to sell nothing for something to another fellow who is trying to buy something for nothing."

How is that for a clever definition?—*Paper Trade Journal.*

* * *

HOW AND WHY.

A COLUMN INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST. GIVE ALL DETAILS AND YOUR NAME AND ADDRESS, WHICH WILL NOT BE PUBLISHED UNLESS DESIRED.

24. A. L. G. says: It is required to force a bushing a given distance into a hole in a block of metal. Which will have the greater tendency to upset or batter the bushing—a slow positive pressure, or one or more blows from a hammer capable of doing the same work as the press? Assume that the whole area of one end of the bushing is acted upon by the hammer at each blow, also by the press? *A.* The hammer will upset the piece far more than the press and tend to rivet the end. The blow of the hammer tends to crush or spread the part struck before the force is communicated to the rest of the body. This is not true of the press, where the pressure is applied slowly and communicated to the whole mass.

25. P. E. W. writes: Kindly give me the address of the party making "reverse" blue prints, as mentioned in your January issue on page 121. *A.* F. Mayer & Co., 170 East Madison St., Chicago, Ill.

26. E. B. writes: Please explain the following table, taken from "Helios," published by the Heine Safety Boiler Company, Prof. R. H. Thurston being the author of the table.

TABLE NO. 1.

B. T. U.		Ft. lbs.		Watts.
1	=	778	=	17.59
42.41	=	33000	=	746 = 1 HP.

Now, as 33 000 ft. lbs. is the mechanical HP. for one minute and 746 watts is the electrical HP. for one second, how and why can they be compared as they are in this table? I can't see how 17.59 watts equal one B. T. U. *A.* Your error is due to considering 746 watts expended in one *second* as a HP. The expenditure of 746 watts of electrical energy gives out work equivalent to 33 000 foot pounds, and when this is done in one minute it is called a horse-power. Dividing 746 by 42.41 gives 17.59 watts, equal to 1 B.T.U. 2. Kindly explain how an ordinary shunt motor regulates. That is, give the reason why the current increases as the work increases? *A.* When an electric motor revolves it generates an electromotive force which is counter or contrary to the one which is driving it. As with a dynamo, the greater the speed the greater the electromotive force generated by the motor, counter to driving current. The effective electromotive force or EMF. is the difference between the driving EMF and the counter EMF. As the speed of motor increases, the counter EFM increases and opposes the flow of current, and the nearer the two EMF's approach—the less current can pass through the motor and the less work it will do. As the load is thrown on the motor, its speed and consequently its counter EMF decreases, more current flows through and more work is done. When the load is sufficient to slow the motor down too much, the counter EMF falls so much that more current than the motor can stand flows through, and the armature burns out if the fuse doesn't protect it by blowing.

27. J. Y. M. asks how to find the center of gravity of a segment of a circle. *A.* While this can be readily found by suspending the desired segment—or a model of it—from two points and noting the intersections of the lines, it is quite a long operation by mathematics. The formula is: Center of gravity of segment $= \frac{c^3}{12\,a}$ where c = chord and a = area of segment. To find the area, we must find the radius of the arc of segment. This formula is:

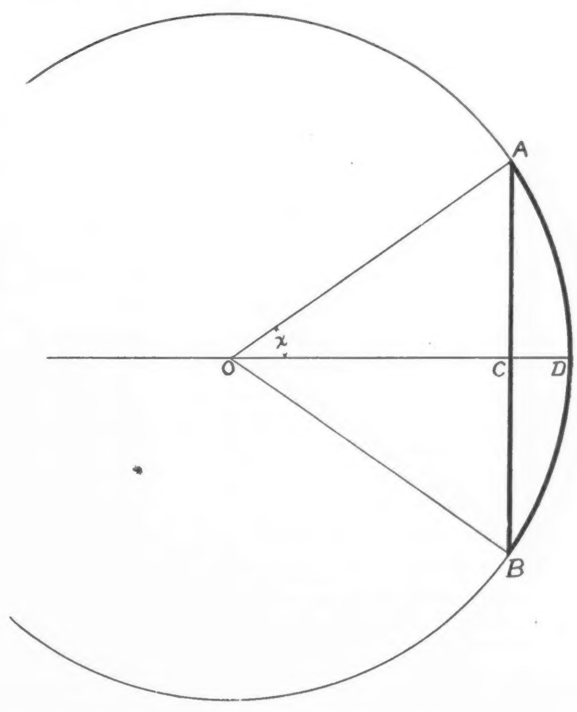
$$\text{Diameter of circle} = \frac{(\frac{1}{2}\,c\,d)^2 + v^2}{v}$$

in which $c\,d$ = chord and v = versed sine. Referring to figure, we have the segment A B D, A B being the chord, and C D the versed sine. Measure this and the chord, for we do not know the angle of arc as yet; if we did, they might also be found mathematically. Finding the diameter by the second formula, take half of this for the radius OD and connect OA and OB. To find area of segment, first find area of sector AOB and subtract the area of the two triangles A C O and B C O, which evidently leaves the area of segment.

First find the angle x by the formula:

$$\text{Sine} = \frac{\text{Side Opposite}}{\text{Hypothenuse}} \quad \text{or sine} = \frac{AC}{OA}$$

In a table of sines find the angle corresponding to this sine, which is the angle x. Double this for the angle of sector (as x is evidently only half the angle). Find area of whole circle and



the area of sector evidently be such portion of this as 360 degrees (or the whole circle) is to angle of sector AOB. Subtracting versed sine CD from radius OD gives OC, one side of triangle, and as the two triangles evidently equal a rectangle with sides equal to AC and OC, then AC × OC = area of triangles. This subtracted from area of sector leaves area of segment. The first formula can now be used, the result giving the distance of center of gravity from the center of the circle of which the segment is a part, *not* from base of segment.

28. J. T. S. writes: What is the best speed for shop-shafting? *A.* No cast-iron rule will fit all cases, or probably any two cases. Depends on tools and class of work. High speed is desirable, as it allows lighter shafting, smaller pulleys and belts to transmit same power; objectionable from increased liability to heat bearings, reducing diameters of driving pulleys so as to cause slip of belts. Both sides of the question must be considered and a happy medium taken for each case. This is where judgment and shop experience comes in. High belt speed is advantageous when it

can be obtained without introducing enough objectionable features to counteract the advantages. A fair average of modern modern shop practice would probably be, for live shafts, from 180 to 200 revolutions per minute.

29. H. M. asks: 1. What will be the effect on the air confined in a tank if the tank is heated. Will the air expand or what? *A.* As it is confined it cannot expand, but its pressure or tension will be increased according to heat applied. Calling its initial pressure 20 pounds, and temperature 60 degrees, the tank to be heated 100 degrees. A very handy formula is $p_1 = p\left\{\frac{460 + t_1}{460 + t}\right\}$

where

p = initial pressure.
p_1 = final pressure.
t = initial temperature.
t_1 = final temperature.

Substituting our known qualities, we have·

$$p_1 = 20\left\{\frac{460 + 160}{460 + 60}\right\} = 20\left\{\frac{620}{520}\right\} = 23.84 \text{ lbs., the pressure}$$

resulting from heating 100 degrees. This shows how slight a compression, or increase of pressure it takes to materially increase the temperature.

2. What is the weight of a cubic foot of free air? *A.* This varies with the temperature. Assume a temperature of 70 degrees, and use formula:

$Pv = .37052 \times T \times W$ where
P = pressure in pounds per square inch.
V = volume in cubic feet.
T = absolute temperature or 460 + temperature of Fahrenheit scale.
W = weight in pounds; for this case we transpose the formula to

$$W = \frac{Pv}{.37052 \times T}$$

Free air is at 14.7 pounds pressure and volume in 1 cubic foot.

$$\text{Then } W = \frac{14.7 \times 1}{.37052 \times (460 + 70)} = \frac{14.7 \times 1}{.37052 \times 530} = .07485$$

pounds per cubic foot at 70 degrees, and 14.7 pounds pressure per square inch.

* * *

* * *

THE Gisholt Machine Co., Madison, Wis., have arranged with Mr. Walter H. Foster to represent them at 128 Liberty St., New York City. The potent words: "Modern Machine Tools," greet the visitor and give him an idea of the class of tools he may expect to see. The Waltham Watch Tool Co. also exhibit the Van Norman milling-machine here.

* * *

WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

AN INSIDE THREADING TOOL.

The writer, in his machine shop experience, made a tool for cutting inside screw threads which may be of interest at the present time, although this device has been used to a limited extent for several years. We made a large number of valves, which were screwed at each end for iron pipe threads, and it was the custom to cut these threads with a single pointed inside thread tool forged from a bar of steel. This was a slow and unsatisfactory method, and as an improved scheme the tool, or chaser, shown in the illustrations, was made. A simple wooden pattern, as shown in Fig. 1, was prepared from which a casting was made and centered for the lathe, as shown. A piece of tool steel of the proper size was then mounted in the slot, and held with a clamp as appears in Figs. 2 and 3, and placed between the lathe centers, when it was turned off a sufficient length to leave a circular surface for the thread to be cut, as shown in Figs. 4 and 5. After which the threads were carefully cut with an ordinary thread tool. The chaser was then released from the arbor and the first two or three teeth backed off as shown in Fig. 4. A slight amount of rake was given by dressing off the top as shown by the dotted line in the end view, Fig. 5.

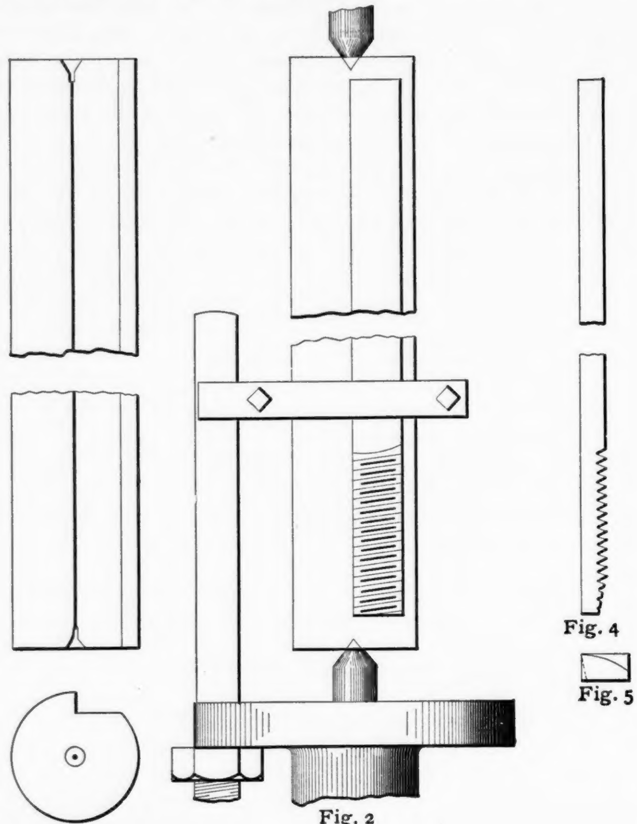


Fig. 1 Fig. 2 Fig. 4 Fig. 5

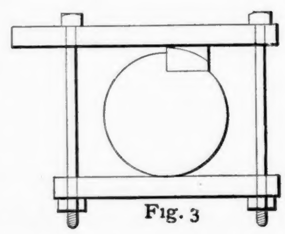


Fig. 3

This will be found to be an inexpensive and handy tool, one answering for all sizes of pipe from 2½ inches up to the largest pipe used with screwed joints, as the threads are the same, eight to the inch. Those who are not familiar with this tool will be surprised at the great amount of work which can be accomplished in a short time, and at the uniform excellence of the threads.

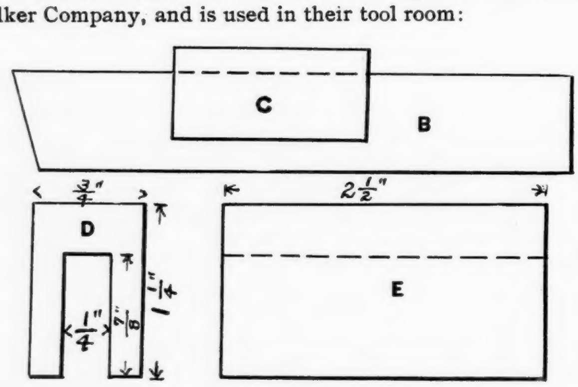
The work is held in the tool post in the usual way, and the amount it will cut at each pass is governed only by the ability of the lathe to pull the cut. By setting the tool at the proper angle the required taper for the pipe fit may be secured. In sharpening, the top of the tool is ground off and it may be ground down three-fourths of its depth without impairing the efficiency.

The first tool made by the writer was in use several years, and performed good work under very severe usage. A. BEMENT.

* * *

HANDY TOOL FOR CUTTING OFF.

The following sketch will probably be of use to any one having to cut off stock in the lathe. It was made by a tool-maker at the Walker Company, and is used in their tool room:



B represents cutting-off tool made from a piece of ¼ x 1¼ inch tool-steel, it being cut off the bar, upset and hardened by the

blacksmith in a few minutes, without forging, as with old-style cutting-off tools. C represents the machine steel tool-holder, which is used to hold tools steady and square in the tool post. You can cut off a piece any diameter up to about 10 inches with it, by using a small steel prop under the cutting end of the tool. It is very cheap as well as handy, as the tool and holder may be made in about two hours. T. B.

Cleveland, O

* * *

ANVIL AND FIDDLE AGAIN.

This is a further contribution to the "anvil and fiddle discussion" from actual practice. Figs. 1 and 2 are outline sketches of an emery grinder doing service in Graff & Co.'s stove foundry at Elizabeth, N. J. Although not drawn perfectly to scale, they show the shape and proportion fairly well.

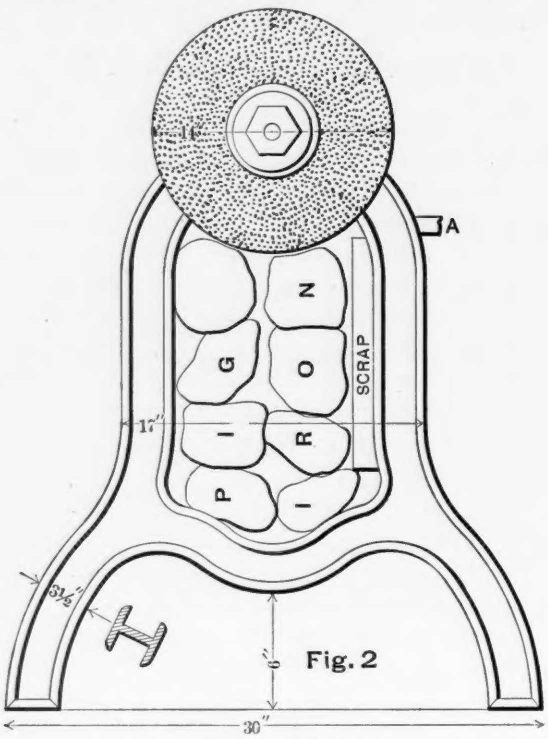


Fig. 2

END VIEW

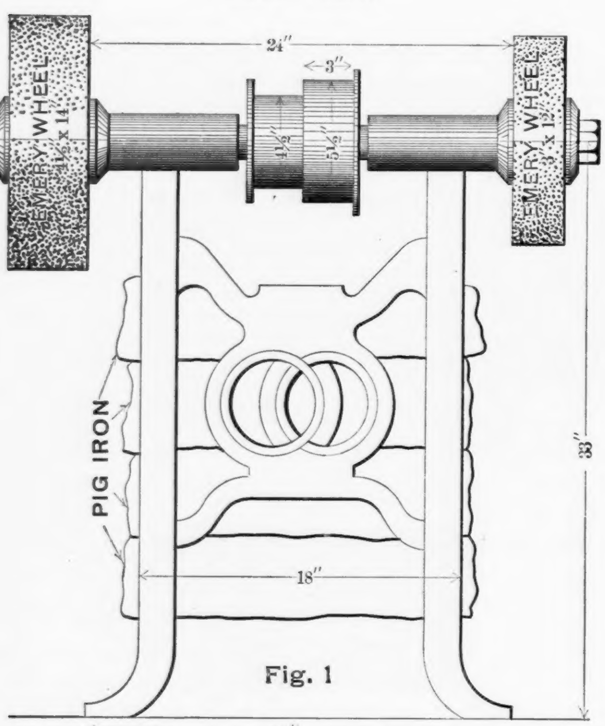


Fig. 1

FRONT VIEW

It was altogether too light, or at least it is much more satisfactory since it was loaded with about half a ton of scrap and pig iron. The load consists of eight pieces of pig iron about 18 inches long, and a piece of scrap $2 \times 6\frac{1}{2} \times 14$ inches, all that could be put in. On the opposite side of the shop was another one loaded with eleven pieces of pig iron about 36 inches long, besides some scrap. The workmen say they were loaded to "prevent their running around the shop and shaking the building down." MILO.

* * *

OIL CAN FILLER.

The filling of oil cans, as commonly practiced, is slovenly and improvident on account of the waste of oil which eventually covers the surroundings, and increases the fire risk.

This device consists of a force pump, with brass cylinder, 1 1-2 x 12 inches long, with brass piston and pressed leather packing and hard steel balls for valves. To the curved neck of this pump is fitted a double tube through which the oil is discharged. The can is placed upon the adjustable platform, operated by the curved lever, at the left, and by it the can is elevated till the mouth of the can forms an air-tight joint, with leather collar surrounding the discharge tube, which consists of two concentric tubes, the center one supplying the oil, while the space between the two vents the can and returns the surplus to the tank, through the curved overflow tube. The syphon action established in the overflow tube draws the oil down to the end of the filling tube, thus leaving ample room to insert the spout without overflowing the can.

The filler shown is provided with a side discharge which is controlled by the faucet. Any vessel that cannot be filled on the platform can be filled here. The spindle to which the platform is attached is hollow, so any oil that might drop from the filling tube will return to the tank. The whole device is built in a first-class manner, is substantial in every detail and will last a life time. It is made by F. D. Winkley & Co., Madison, Wis.—*Adv.*

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B. & O. NEW ELECTRIC PLANT.

The electric power plant, at Baltimore, of the B. & O. R.R. Co. is now being used not only to furnish the power for the tunnel motors, but to run 180 street cars of the Baltimore Traction Company, to light the Camden Station and yards, the Baltimore City tunnel, the Locust Point freight houses, warehouses and yards, Mt. Clare shops and the splendid new Mt. Royal passenger station. It is also probable that they will re-construct their Camden Station, in Baltimore, so that passenger trains will not have to back in and out as has to be done at present. It is contemplated to erect new passenger sheds and necessary buildings near the mouth of the tunnel by which the movement of trains between Washington and New York will be greatly accelerated.

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MANUFACTURERS' NOTES.

THE GEORGE BURNHAM COMPANY, Worcester, Mass., have just made a large sale of their drills to the Hungarian Railway Company, which is especially noteworthy in view of the fact that the Hungarian Government is particularly adverse to buying machinery that is made out of their own country.

MR. CHARLES DAVIS, president of the Davis & Egan Machine Tool Co., of Cincinnati, Ohio, has just returned from a six months' trip to Europe, where he visited Russia, Germany, France, Austria, Norway, Sweden, Belgium, Holland, Denmark and England, establishing agencies in all the large cities in these countries. He secured many large orders direct from the consumers, and as a result of his trip the company is now working nearly six hundred men twelve hours per day, and have orders on their books to keep them running full force until the first of May.

THE HART M'F'G. CO., No. 10 Wood St., Cleveland, Ohio, report the demand for their well-known Duplex Adjustable die stocks to be constantly on the increase, the year 1896 having been the largest in amount of sales, since they have been in business. They say that for the entire period, since 1894, they have never seen the day when they were less than from three to six months behind their orders. They inform us that since the return in August last, of their Mr. Charles Hart, from a year's stay in Europe, they have left no stone unturned in their efforts to immediately and effectually increase their facilities for turning tools out rapidly. This has been accomplished by the addition of

a considerable amount of such new machinery as would best meet their requirements, regardless of its cost. The Hart Mfg. Co. also say that they are having built several of the most improved machines of a special design, peculiarly adapted for their work. As soon as these are in working order, their capacity for producing Duplex tools will be fully quadrupled, and the manufacturers are always willing to furnish lists and full information upon request.

* * *

BUSINESS.

NO CHARGE IS MADE FOR THE INSERTION OF BONA FIDE ITEMS UNDER THE ABOVE HEAD. FOR FURTHER PARTICULARS, ADDRESS THIS OFFICE.

MR. C. R. MEAD, East Syracuse, N. Y., wishes to purchase a second-hand engine and boiler, of about 40 Horse Power, and desires information as to make, type and price.

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FRESH FROM THE PRESS.

Combustion and Smoke Prevention on Locomotives. Angus Sinclair. Press of *Locomotive Engineering, New York.* 43 pp., 3½ x 6 inches. Price, 25 cents.

This is a handy little pocket treatise on the subject named, which is receiving much attention at present and seems likely to be more important in the future. The author is one of the best authorities on railway matters in this country, and having risen from the ranks himself, knows how to make things plain to the men who need such books. It is a thoroughly practical little book and will be of value to any mechanic, whether a fireman or not, as he will get a better idea of what constitutes good firing than in any way we know of.

The Tradesman, Chattancoga. Tenn.

The 18th annual number of The Tradesman, published at Chattanooga, Tenn., contains over 260 pages, and presents a most complete, exhaustive and valuable review of the South, its resources, development and possibilities. The special articles are from the leading thinkers, statisticians and business men in our country; the information given is the result of careful investigation and practical knowledge. The business directories and statistics are most valuable features of this number, and it will be preserved as a reference book on all subjects pertaining to the South and its resources. One of the many features is a complete directory of 5,000 of the leading industrial plants of the Southern States.

ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9X12, 6X9 AND 3½X6 INCHES. THE 6X9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

AMERICAN STEAM GAUGE COMPANY, Boston, Mass. Catalog of Gauges, Indicators, etc. 644 pages, 6 x 9 inches.

Besides the steam and other gauges, pop valves, lock-up safety valves, etc., there is considerable space devoted to describing the Thompson improved indicator, made by them. This gives much valuable information to engineers and others interested in these instruments. The section on "Testing Indicator Springs" is extremely interesting, and insures the book being preserved for reference.

WATERBURY FARREL FOUNDRY & MACHINE CO., Waterbury, Conn.

The advance sheets of their catalog show miniature cuts of machines for different purposes, and are divided into sections, accordin-to work done by machine. They include machinery for rolling mill tube, rod and wire mill, silverware and coining, hardware and brass goods, and bicycles, of course.

R. M. CLOUGH, New Haven, Conn, Catalog of Gear and Milling Cutters.

The Duplex cutters for gear teeth, which have caused so much discussion on both sides of the question, are shown and listed here, together with the single involute cutter, milling cutters, slotting saws, adjustable shell reamers and quite a line of small tools for the tool room. Mr. Clough's long experience enables him to know what tools are needed in the shop, and he evidently proposes to supply the need.

NEW YORK AS A WINTER RESORT; "Four Track Series No. 18." N. Y, C &. H R. R.

A neat 64 page booklet containing in compact and get-at-able form a large variety of useful information concerning things to see and how to see them, as well as a good list of hotels, restaurants, theatres and retail stores of the city of New York. It is nicely illustrated, presenting a good selection of the leading attractions of the great city. Those who know New York only as a business center will find in this little book a pleasing and instructive glimpse of the quiet and more enjoyable side of life in Gotham. Copies of this can be had by sending two 2-cent stamps to Mr. Geo. H. Daniels, general passenger agent, Grand Central Station, New York City.

We hate to blow our own horn,

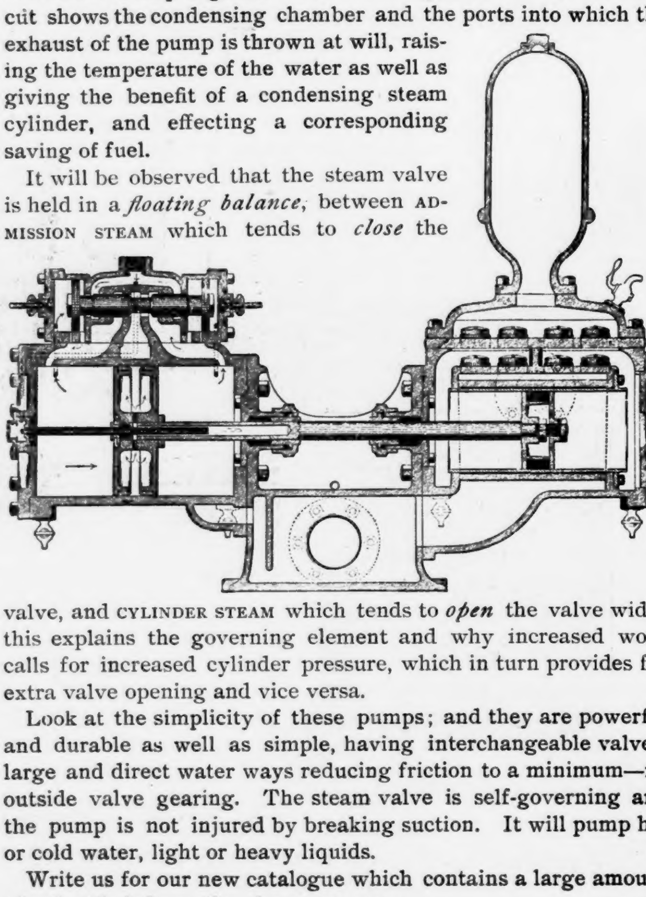
F. D. Winkley & Co. of Madison, Wis., manufacturers of Dust Proof Oil Hole Covers, who are not advertising in any paper except MACHINERY, state that they have received an inquiry for 5,000 of their covers from Copenhagen, and take occasion to add that they have lately received orders from England, Paris, Berlin, Budapest and other points in Europe, not to mention those received from the United States, in regard to which they say "Of course we give MACHINERY the credit."

But sometimes it seems necessary.

POINTERS ON PUMPS.—II.

In last month's talk we gave a few figures relating to the efficiency of boiler feed pumps; in this article we show a sectional view of the Marsh Steam Pump (sizes, 150 to 1 500 horse power capacity), which enables an engineer to see *why* the efficiency of the Marsh Pump is greater than its competitors. The sectional cut shows the condensing chamber and the ports into which the exhaust of the pump is thrown at will, raising the temperature of the water as well as giving the benefit of a condensing steam cylinder, and effecting a corresponding saving of fuel.

It will be observed that the steam valve is held in a *floating balance*, between ADMISSION STEAM which tends to *close* the



valve, and CYLINDER STEAM which tends to *open* the valve wide, this explains the governing element and why increased work calls for increased cylinder pressure, which in turn provides for extra valve opening and vice versa.

Look at the simplicity of these pumps; and they are powerful and durable as well as simple, having interchangeable valves, large and direct water ways reducing friction to a minimum—no outside valve gearing. The steam valve is self-governing and the pump is not injured by breaking suction. It will pump hot or cold water, light or heavy liquids.

Write us for our new catalogue which contains a large amount of valuable information for steam users.

THE BATTLE CREEK STEAM PUMP CO., Battle Creek, Mich.—*Adv.*